Supplement to Current Science

Current Science, Vol. XL, 1971

Author Index

PAGE

ABDEL-GAWAD, M. M. 631
Abichandani, C. T. 641
Aboobaker, V. O. 518
Abraham, C. C. 498
Abraham, J. C. B. 469
Abraham, P. M. 348
Abrol, Y. P. 381, 414
Acharya, R. M. 661
Adgaonkar, C. S. 656
Adinarayana, D. 602
Adinarayana Reddy, K. 372
Agarwal, S. C. 583
Agnihothrudu, V. 20
Agrawal, R. D. 378
Ahmad, H. 67
Ahuja, V. P. 58
Aiyyappan Nair, K. 187
Alagianagalingam, M. N. 381
Alaka Pande (Mrs.) 554
Ambaya, R. Y. 158
Ambwani, K. 167
Anand, G. V. 244
Ananda Rao, T. 551
Anahosur, K. H. 116
Ananthakrishnan, R. 221
Anantharaman, T. R. 307
Anjanappa, K. 406, 572
Anjaneya Sastry, B. 309
Annapurna, S. 581
Appaiah, K. M. 19
Aravamudan, G. 629
Arora, C. L. 661
Arora, I. 142
Arora, S. 28
Ashrafunnisa (Miss) 317
Asundi, R. K. 242
Aswathanarayana, U. 663
Ayengar, K. N. N. 601
Aylward, G. H. 321

BADU, K. C. 292
Bagavant, G. 350
Bahadur, K. 402
Bahl, C. P. 27
Bains, K. S. 413

PAGE

Bakore, G. V. 84
Balakrishnan Nair, N. 161
Balakrishna Rao, D. 160
Balasubramanian, M. 69
Balasundaram, V. R. 441
Bal Krishna 346
Banerjee, B. 63
Banerji, K. K. 84
Bappu, M. K. V. 217
Bapukutty, K. 189
Barooah, B. C. 449
Baruah, G. D. 251, 655
Barve, V. P. 190
Basu, K 86, 603
Basu, R. N. 427
Basu, S. L. 297
Batta, A. K. 630
Berlin, O. G. W. 437
Betrabet, S. M. 423
Bhaduri, P. N. 584
Bhagavantam, S. 207
Bhagwan Das 660
Bhama, K. S. 45
Bhambure, C. S. 196
Bhan, M. K. 570
Bhapkar, D. G. 91
Bhargava, H. N. 575
Bhargava, P. 191
Bhargava, P. N. 430, 658
Bhargava, V. K. 191
Bhaskaran, K. 281
Bhaskaran, R. 171
Bhaskaran, U. P. 90
Bhat, J. V. 662
Bhat, N. T. 518
Bhat, S. G. T. 9
Bhat, S. N. 483
Bhat, U. K. M. 354
Bhatia, K. C. 110
Bhatia, R. Y. P. 323
Bhatt, Bharati 70
Bhattacharjee, A. J. 463, 546
Bhattacharya, S. 159
Bhattacharya, S. K. 86, 455, 603
Bhavanarayana, P. V. 573

PAGE

Bhave, S. V. 656
Bhola Nath 657
Bhupal, O. P. 551
Bilgrami, K. S. 668
Billimoria, K. N. 611
Boraiah, G. 608
Borkar, V. D. 433
Bose, P. 165
Bose, S. 500
Braganza, D. A. 34
Burman, R. 61

CHAKRABORTY, R. 185
Chakraborty, S. 88
Chandra, G. 400
Chandra (Miss) H. 566
Chandra, K. 571
Chandra, R. 526
Chandrasekhar, S. 235
Chandra Sekhar, V. S. G. 136
Chandrasekharan Nair, M. .. 18
Channabasavanna, G. P. 523
Chary, Ch. M. 471
Chatterji, U. N. 40
Chaturvedi, M. 156
Chaturvedi, Y. 519
Chaudhary, A. K. 459
Chauhan (Mrs.) M. G. 328
Chavan, A. R. 642
Chawan, D. D. 93
Chennaveeriah, M. S. 668
Chikkannaiah, P. S. 668
Chincholkar, V. S. .. 62, 154, 400
Chinnadurai, G. 18
Chiplonkar, G. S. .. 433, 632
Chiplonkar, V. T. 261
Chopra, G. R. 267
Choubey, V. N. 322
Chowdhery, H. J. 412
Chowdhury, S. R. 353

DAKSHINAMURTI, C. .. 35, 179
Dale, D. 369
Damodaran, C. 373
Darshane, V. S. 319, 345
Das, A. K. 195
Das, N. 501
Das, P. K. 17, 86, 455
Das, R. C. 292
Das, S. N. 168
Dasgupta, B. 86, 455, 603
Datta, R. M. 329
Dave, L. D. 547
Davis, M. 351
De, R. 90

Debnath, P. K. .. .. ..
Desai, A. J. .. .. ..
Desai, M. V. M. .. .. ..
Desai, Y. R. .. .. ..
Deshpande, G. G. .. .. ..
Deshpande, V. T. .. .. ..
Deshpande, V. V. 510,
Deshpande, Y. H. .. .. ..
Devaprabhakara, D. .. .. ..
Devaraj Sarkar, H. B. .. .. ..
Dharam Vir 41,
Dhingra, B. .. .. ..
Dhingra, (Miss) H. K. .. .. ..
Dhingra, O. D. .. .. ..
Dhuria, H. S. .. .. ..
Diwan, V. V. .. .. ..
Dixit, P. C. 435,
Doraiswamy, S. .. .. ..
Doshi, G. R. .. .. ..
Dube, P. S. .. .. ..
Duraiswamy, S. .. .. ..
Durga Prasad, K. .. .. ..
Dwarakadasa, E. S. .. .. ..
Dwarkanath, S. K. .. .. ..

EBENEZER RAJA, E. .. ..

FATEH BAHADUR .. ..
Fathima, T. .. .. ..
Fazalnoor, K. .. .. ..
Fernandez, A. C. .. .. ..
Francis, D. J. .. .. ..

GAIKWAD, D. G. .. ..
Gaikwad, U. D. .. .. ..
Ganapathy, K. .. .. ..
Ganapathy, S. .. .. ..
Ganapati, P. N. .. .. ..
Ganguly, A. K. .. .. ..
Ganguly, K. .. .. ..
Garg, B. S. .. .. ..
Gassi (Miss) S. .. .. ..
Gaur, A. 41,
Gaur, A. C. .. .. ..
George, V. .. .. ..
Ghate, N. S. 87,
Ghosal, D. K. .. .. ..
Ghose K. C. .. .. ..
Ghosh, S. K. .. .. ..
Ghosh, S. N. 29,
Gill, A. S. .. .. ..
Gill, B. S. .. .. ..
Gill, K. S. 413,
Gnanapragasam, N. S. .. .. ..
Godbole, S. H. .. .. ..

PAGE

Gopal, V. 254
Gopalakrishna, A. 490
Gopalakrishna, G. 627
Gopalakrishnan, R. 498
Gopalgowda, H. S. 494
Gopinath, D. M. 259
Gore, P. S. 48
Goswami, B. K. 469
Govindaswamy, C. V. 273
Gowardhan, A. K. 628
Goyal, S. K. 165
Gulrajani, M. L. 374
Gupta, B. M. 571
Gupta, B. S. S. 131
Gupta, J. H. 442
Gupta, P. K. 444
Gupta, R. 141
Gupta, R. K. 307, 461
Gupta, S. C. 470
Gupta, S. K. .. 64, 365, 597, 640
Gupta, V. J. 435, 490
Gurumani, N. 325, 634

HABIB, A. F. 67
Hakim, K. L. 126
Hammouda, F. M. 631
Hariharan, P. 648
Hariharan, V. 106
Hashimi, N. H. 38
Hayat, Ram 499
Hegde, K. T. M. 618
Hegde, R. K. 611
Hingorani, S. B. 121
Huddar, B. B. 290
Hunsigi, G. 582
Husain, A. 197

IDNANI, M. A. 158
Indap, M. A. 158
Indira Chary, G. A. 421
Isaac, I. 416
Israel, P. 497
Iyer, P. K. R. 110, 135

JACHUCK, P. J. 274
Jagadeesh, K. M. 148
Jagadiswara Rao, R. 434
Jain, A. C. 156, 267
Jain, H. K. 383
Jain, S. K. 29
Jamaluddin 415
James, P. S. B. R. 520
Jana, B. B. 491
Janakamma, C. 256
Janaki Ammal, E. K. .. 70, 544

PAGE

Janardhanan, K. K. 197
Jani, Y. K. 464
Jayachandra 568
Jayaraman, A. 247
Jayaraman, K. N. 198
Jindal, J. K. 498
Johar, G. S. 547
Joseph, N. 83
Joseph, P. T. 189
Joshi, Sumati, A. 579
Joshi, R. V. 13

KACHROO, R. K. 633
Kakar, S. N. 661
Kale, P. P. 515
Kalyanam, N. P. .. 15, 325, 634
Kamat, S. S. 190
Kamboj, V. P. 353
Kandasamy, D. 113
Kandasamy, R. 496
Kandaswamy, T. K. 557
Kankonkar, R. C. 563
Kannaiyan, J. 557
Kantharaj, G. R. 139
Kapoor, A. S. 550
Kar, A. B. 353, 659
Karande, A. A. 109
Karanth, N. G. K. 394
Karim, (Miss) K. B. 490
Karnik, R. R. 129
Karunakaran, K. 32, 498
Kasinathan, S. 297
Kaul, A. K. 28, 58, 150
Kauffman, H. E. 271
Kaul, A. K. 652
Kavimandan, S. K. 349
Kedar, S. P. 34
Kempanna, C. 301
Khaire, V. M. 91
Khan, E. 37
Khanna, A. 529
Khanna, K. R. 555
Khanna, P. L. 505
Khanna, U. 124, 369
Khare, M. N. 612
Khare, P. L. 656
Kher, V. G. 264, 656
Khera, S. 519
Khushu, C. L. 524
Knypl, J. S. 294
Kothandaraman, H. 598
Kothandaraman, R. 171
Krishnaiah, K. S. R. 266
Krishna Iyer, P. V. 430
Krishna Kumar, S. 459

Bl
Bl
Bl
Bi
Bi
Bo
Bo
Bo
Bo
Bra
Bu

CH
Ch
Ch
Ch
Ch
Cha
Ch
Cha
Cha
Cha
Cha
Cha
Cha
Cha
Cha
Cha
Cha
Cha
Che
Chil
Chi
Chir
Chip
Chip
Cho
Cho
Cho
Cho

DAK
Dale
Dam
Dars
Das,
Das,
Das,
Das,
Das,
Dasg
Datt
Dave
Davi
De,

	PAGE
Krishnamoorthy, C.	666
Krishnamoorthy, T. M.	279, 542
Krishnamurthy, C. S.	381
Krishnamurthy, K. V.	259
Krishnamurthy, V.	295
Krishnamurti, C. R.	589
Krishnamurthy, Bh.	155
Krishnan, R. S.	227
Krishna Pillay, K.	161
Krishna Rao, M.	480
Krishna Rao, P. R.	218
Krishna Rao, P. S. R.	372
Krishna Sastry, K. S.	19
Krishnaswamy, N. R.	267
Kshirsagar, K. K.	196
Kuchela, K. N.	265, 511
Kulkarni, P. R.	132
Kulkarni, U. K.	443
Kumar, S.	401
Kunda Deval	662
Kuriacose, J. C.	10
LAKSHMAN, S. V. J.	316
Lakshmana Rao, M. V.	409
Lakshminarasimham, C.	553
Lakshminarayana, C. S.	148
Lakshminarayana, R.	259
Lakshminarayana, V.	101, 458
Lal, B. B.	655
Lal, Jawahar	147
Lal, O. P.	300
Lal, R.	86, 455
Lalithakumari, D.	273
Lal Mohan, R. S.	637
Laura, R. D.	158
Lee, R. W.	321
Leela, D.	296
Likhite, S. D.	1
Lodha, B. C.	137
Loyal, D. S.	384
MADHAVA, M. S.	288
Madhavarao, B. S.	232
Magar, N. G.	642
Magu, S. P.	416
Mahal, H. S.	190
Mahesh, R. P.	401
Maheshwari, R. K.	571
Maiti, S. C.	388
Majumdar, (Miss) G.	547
Majumdar, P. K.	356
Majumdar, T. K.	584
Makde, K. H.	327
Malik, R. S.	298

	PAGE
Manavalaramanujam, R.	574
Mandal, S. N.	463, 546
Mani, (Miss) A.	240, 290
Manjunath, A.	667
Mannikar, N. D.	641
Masood, A.	346
Mataney, C. F.	110
Mathew, E.	75
Mathur, J. M. S.	499
Mazurczyk, W.	294
McLintock, I. S.	599
Mehdi, Vimal	381
Nagendra Nath, N. S.	234
Mehrotra, K. N.	369
Methta, R. K.	461
Mensinkai, S. W.	67
Merchant, J. R.	353
Miller, P. J.	339
Mishra, R. K.	111
Misra, R. M.	100
Misra, S. S.	11, 657
Misra, T. K.	440
Modak, S. G.	264
Mohanty, G. C.	55, 181
Mohapatra, A. R.	518
Mohapatra, B. K.	599
Mukerjee, S.	477
Mukhopadhyay, A. K.	388
Mullick, P.	40
Muraleedharan, N. Y.	152
Murthy, A. S. N.	483
Murty, A. S.	555
Murty, C. R. K.	62
Murty, G. V. L. N.	266
Murty, S. V. S. S.	26
Muthana, M. S.	400
Muthukrishnan, K.	48
NAGARAJAN, S.	19
Nagendra Nath, N. S.	23
Nagpal, U. S.	16
Naidu, M. G. C.	1
Naik, M. S.	
Nair, A. G. R.	157, 40
Nair, Lizzie, N.	5
Nair, P. M.	2
Nanda, K.	4
Nandi, B.	1
Narasimha Murthy, S.	3
Narayan, K. S.	
Narayana, H. S.	7, 1
Narayana, R.	
Narayanan, E.	6
Narayana Rao, L.	1

PAGE

Narayanaswamy, B. C. 116
Nariani, T. K. 299, 469, 552
Narkhede, M. N. 527
Narlikar, V. V. 104
Nataraja, K. 668
Nayar, K. K. 606
Nayar, M. N. S. 570
Nayeemunnisa 664
Nayudu, M. V. 670
Neelameghan 131
Nigam, H. L. 600

OJHA, P. P. 550
Ong, E. T. 44

PADHYE, M. R. 129, 374, 628
Padmanabhan, V. M. 60
Paik, P. 384
Pal, B. P. 533
Palanichami, K. 610
Paliwal, G. S. 114
Pande, P. C. 268
Pandey, A. P. 181
Pandey, D. B. 100
Pandey, D. C. 385
Pandey, R. K. 459
Pandey, R. M. 356
Pandey, V. B. 455
Pandeya, K. B. 600
Pandian, T. J. 636
Pandian, T. T. 416
Pandotra, V. R. 442
Panikkar, N. K. 215
Panse, T. B. 158
Pant, D. D. 242
Panwar, R. S. 383
Parameshwar, N. S. 582
Pardhasaradhi, Y. J. 376
Parthasarathi, K. 640
Patel, K. R. 547
Patel, L. K. 288
Patel, P. N. 498
Patell, J. R. 353
Patil, B. N. 582
Patil, D. R. 407
Patil, K. C. 187
Patil, P. V. 62
Patil, R. B. 494
Patwardhan, B. H. 350
Paul, B. 106
Pavgi, M. S. 303
Payak, M. M. 529
Peshwa, V. V. 27, 87
Phadke, A. V. 37
Phadke, K. M. 34
Phadnis, B. A. 527
Phansalkar, V. G. 377
Phul, P. S. 89
Pillai, T. N. V. 75
Pillayarsamy, K. 381
Pisharoty, P. R. 222
Powar, K. B. 377
Prabhamani Patil 561
Prabhu, K. R. 320
Prakash, B. 346
Prasad, E. A. V. 14
Prasad, M. 140, 625
Prasad, N. N. 171, 198, 496
Prasad, N. V. S. R. K. 114
Prasada Rao, P. D. .. 407, 604
Premswarup, D. 154
Pugashetti, B. K. 494
Purushothaman, D. .. 113, 670
Pushpa Lata 4

QADRY, J. S. 328

RADHAKRISHNAMURTY, C. .. 1
Radhakrishniah, M. 602
Raghavaiah, P. 58
Raghunath, D. 196
Raghunathan, K. 464
Raghupathi Rao, C. .. 372, 546
Raghunathan, V. 113, 670
Rai, B. 459
Rai, H. 633
Rai, J. N. 412, 583
Rai, S. N. 459
Raja, P. K. S. 1
Rajagopalan, S. R. 647
Rajaram, J. 10
Rajaram, P. 318
Rajasekhara, B. M. 451
Rajasekhara Rao, J. 602
Raju, P. C. 104
Rajya, B. S. 55, 181
Rajyalakshmi, B. 143
Rajyam, B. S. 62
Ram, K. V. S. 434
Ramachandran, G. N. 212
Ramachandran, V. 367
Ramachandra Rao, R. 636
Ramachandra Rao, V. 432
Ramadoss, C. S. 12
Ramaiah, B. K. 451
Ramakrishna, B. S. 244
Ramakrishnan, C. V. 97
Ramakrishna, J. 486
Ramakrishna Rao, T. V. 316

PAGE
Raman, Sir C. V. (Photograph) facing page .. 203
Ramana Rao, A. V. 196
Ramana Rao, D. V. .. 106, 599
Ramana Rao, V. V. 486
Ramana, K. V. R. 293
Ramanathan, J. D. 464
Ramanathan, K. R. 203
Ramanujam, V. M. S. 348
Ramaprabhu, T. 367
Rama Rao, C. G. 186
Rama Rao, K. 34, 345
Rama Rao, L. 211
Ramarao, P. 471
Rama Rao, S. 19
Ramasastry, C. V. 62
Ramaseshan, S. 248, 648
Ramaswamy, C. 219
Ramachander, R. B. 627
Ramdas, A. K. 237
Ramdas, L. A. 224
Ramiah, N. 187
Ram Udar 638
Randhawa, H. S. 187
Ranganath, G. S. 649
Ranganathan, G. 107
Ranganathan, N. S. 107
Rangarajan, S. K. 175
Ranga Rao, V. 357
Rangaswami, S. 36, 84, 106, 464, 601, 630
Rao, A. N. 44
Rao, C. H. 499
Rao, D. V. K. 516
Rao, P. R. 81
Rao, P. S. 640
Rao, P. S. 271
Rao, P. T. 186, 317, 516
Rao, S. R. 25
Rao, S. S. 563
Rao, V. G. 169, 444
Rao, Y. S. 17, 497
Rastogi, D. K. 396
Rathaiah, Y. 303
Ratho, S. N. 274
Raut, R. N. 383
Rawal, Y. B. 116
Raychaudhuri, S. P. 272, 299, 469, 552
Reddy, A. R. 335
Reddy, Y. P. 186
Reddy, B. R. K. 186, 317
Reddy, G. M. .. 136, 164, 335, 581
Reddy, P. V. G. K. 367
Reddy, S. M. 668
Reddy, T. P. 163
Reddy, Y. P. 317

PAGE
Rege, D. V. 132
Rizk, A. M. 631
Roy, J. K. 497
Roy, P. M. 46
Roy, R. P. 46
Rudraiah, N. .. 256, 343, 451, 561

Sadasivan, T. S. 208
Sah, R. L. 55
Saha, S. B. 410
Sahota, H. S. 289
Sahu, G. 292
Saksena, D. N. 65
Sali, S. A. 13
Sambe Gowda, S. 617
Sampath, S. 111
Sankaran, T. 641
Sankara Subramanian, S. 85, 157, 194, 404
Sankar Naidu, M. 666
Sankhla, N. 140, 302
Santappa, M. 32, 598, 623
Santhakumaran, L. N. 199
Santra, D. K. 548
Santra, S. 166
Saoji, A. N. 548
Saraf, A. P. 192
Sarkar, H. L. 491
Sarma, N. P. 595
Sarma, T. P. 279
Sarma, V. A. K. 35
Sarma, V. S. 438
Sarma, Y. R. 670
Sasmal, P. K. 329
Sastri, M. V. C. 318
Sastry, K. S. M. 442
Sastry, V. N. 279, 542
Sathe, A. V. 42
Satyanarayana, D. 292
Satyanarayana, G. 458
Savithry, T. 516
Saxena, A. P. 273, 355
Saxena, D. N. 575
Sejekan, B. G. 629
Seetharam, A. 301
Sehgal, K. L. 413
Semenov, E. I. 254
Sen, D. N. 93
Sen, P. K. 388
Sen Gupta, P. K. 168
Seshadri, C. V. 434
Seshadri, R. 84
Seshadri, T. R. 27, 209, 267, 464, 505, 594
Seshadri, V. 630
Seth, B. R. 233
Seth, C. B. 192

PAGE

Seth, M. L. 272
Sethi, G. S. 557
Sethi, P. D. 85
Sethi, R. P. 43
Setty, B. S. 659
Shah, C. S. 328
Shah, D. O. 350
Shah, N. L. 493
Shah, S. M. 25
Shanker, R. 341
Shanmugham, K. 16
Shanmugasundaram, E. R. B. 12, 107, 373
Sharma, A. 51
Sharma, K. 438
Sharma, K. D. 93
Sharma, M. K. 7
Sharma, N. L. 633
Sharma, O. P. 525
Sharma, S. D. 126
Sharma, S. D. 391
Sharma, S. D. 398
Sharma, T. R. 150
Sharma, U. K. 64
Sheikh, M. T. 66
Sheriff, A 607
Shethna, Y. 269, 626
Shetty, H. P. C. 410
Shivaramiah, G. 606
Shivashankar, G. 301, 667
Shringi, Sharada, 563
Shrivastava, P. S. 16
Shukla, R. 462
Shukla, R. V. 365, 597
Shyamala Krishna Sayee 620
Siddiq, E. A. 391, 610
Singh, C. B. 28, 286
Singh, D. K. 39
Singh, D. P. 500
Singh, D. V. 272
Singh, I. D. 625
Singh, I. S. 341, 655
Singh, J. 480
Singh, J. P. 547
Singh, M. 129
Singh, N. 293
Singh, R. K. 126
Singh, R. N. 356, 430
Singh, R. P. 21, 352
Singh, S. R. 251
Singhi, V. C. 461
Singh, V. P. 142, 610
Sinha, A. K. 501
Sinha, A. P. B. 239
Sinha, G. C. 356

PAGE

Sinha, K. P. 650
Sinha, S. K. 402
Sinha, V. B. 281
Siromoney, (Mrs.) R. 650
Sivarama Sastry, G. 309
Sood, B. S. 129
Solankure, R. T. 169, 444
Sreedhar Murthy, M. 324, 375
Sreenivasan, T. V. 544
Sreenivasa Rao, P. 116
Sridhar, N. 10
Srinivasachar, D. 147, 163, 298, 311
Srinivasachar, H. R. 453
Srinivasan, H. 92
Srinivasan, K. S. V. 32
Srinivasan, V. 318
Srivastava, A. N. 365, 597
Srivastava, G. P. 290
Srivastava, K. S. 351
Srivastava, P. C. 600
Srivastava, P. S. 337
Srivastava, V. K. 665
Subbarami Reddy, D. 179
Subbarao, K. 104
Subba Rao, M. 121
Subba Rao, N. S. 416
Subhedar, N. 604
Surbamanian, G. 665
Subramanian, V. 254
Subramanyam, K. N. 379
Subramanyam, S. 578
Subramoni Iyer, V. 106
Sulaiman, M. 112
Sulla, S. B. 313
Sulochana, N. 194
Sundarabai, A. 453
Sundara Rajan, S. 554
Sundara Rajulu, G. 134, 467
Suneja, I. J. 466
Suryanarayana, K. V. 284, 406
Suryanarayana, S. V. 487
Swami, K. S. 160
Swaminathan, M. S. 391
Swaminatha Reddy, B. 344, 625
Swarup 39
Swamy Rao, T. 67

TANDON, K. K. 436
Tandon, K. K. 438
Tandon, M. P. 415
Tandon, R. N. 415
Tandon, S. K. 84
Tapaswi, P. M. 632

PAGE

Tewari, N. C. 36, 601
Tewari, R. S. 12, 462, 657
Thakkar (Mrs.) S. M. 353
Thakre, O. B. 62
Thakur, R. N. 197
Tharian, P. C. 156
Thilagar, A. K. R. 437
Thite, A. N. 443
Thomas, B. 498
Thomas, M. K. 109
Thyagaraja, B. S. 577
Tiwari, G. L. 330, 385
Tiwari, S. N. .. .. ..
Trivedi, B. S. 167, 526
Trivedi, K. N. 350

UDUPA, M. R. 629
Ullasa, B. A. 169
Uma, M. C. 359
Untawale, A. G. 327
Upadhya, M. D. 524
Upasani, K. R. 264
Uprety, D. C. 414
Usha Gopal Rao 607

VADHAR, P. M. 116
Vaidya, P. C. 288, 651
Vaidyanadhan, R. 376
Vaidyanath, K. 164
Valvoda, V. 459
Varadarajan, S. 404
Varghese, A. G. 409
Varma, A. 299
Vasantharajan, V. N. .. 394, 662
Vasudevan, S. 265
Vedantham, T. N. C. .. 27, 267
Ved Brat, S. 411
Vellanki, J. M. R. 126
Venkata Chalapathi, V. 363
Venkatacharyulu, P. 154
Venkata Rao, D. 193
Venkata Rao, E. 193
Venkataraman, G. 646

PAGE

Venkataraman, G. S. 43, 67, 143, 165
Venkataraman, K. 239
Venkata Ramana Rao, K. 101
Venkata Ramiah, K. .. 363, 421, 620
Venkata Reddy, P. 578
Venkata Subbaiah, M. C. 160
Venkatasubramanian, N. 348
Venkateswara Rao, P. 160
Venkateswarlu, B. 268
Venkateswarlu, V. 320
Verghese, J. 152, 348
Verma, A. C. 612
Verma, J. P. 21
Verma, P. K. 311
Verma, V. K. 404
Vidhyasekaran, P. .. 273, 557
Vijayalakshmi, K 511
Vijayan, M. 262, 489
Vijayaraghavan, V. R. 623
Virendra Nath 638
Virmani, R. N. 352
Virmani, S. S. 22
Viswamitra, M. A. .. 344, 459, 625
Viswanath, D. P. 19
Viswanathan, B. 318
Viswanathan, R. 344
Viswanath, S. M. 552
Viswanatha, S. R. 667
Visweswar, T. 155
Viziakumar, A. 438
Vyas, S. R. 124, 269
Vyawahare, A. R. 154
Vydeeswaran, S. 594

WACHASUNDER, S. D. 264
Waditwar, A. M. 34
Watton, E. C. 321

YADAV, B. S. 612
Yadava, C. P. 497
Yadav, V. S. 60
Yashvir 444

Subject Index

PAGE

ABSCISIC Acid Induced Chlorophyll Degradation, Inhibition of, by Potassium 302
Absorption Spectrum of Bis (2-Methylpyridine) Nickel (II) Chloride in 2-Methylpyridine 321
Acetophenone, 2-Hydroxy-5-Methyl, as an Analytical Reagent for Fe(III) .. 372
N-Acetylacetoneanthranilic Acid, Bivalent Metal Ion Complexes of .. 461
Achaetomium uniapiculatum, A New Species of the Genus *Achaetomium* 412
Acid Phosphate in Human Semen, A New Colour Reagent for the Detection of 323
Acrocarpus frascinifolius, A Leaf Spot of 20
Adhathoda vasica, Crystalline Chemical Components of the Flowers of .. 84
Adsorption Experiments, Calibration of Sample Tube Dead Space in, Without Using Helium 9
Aeginetia indica, In vitro Culture of the Seeds of Root Parasite .. 668
Agriculture, Science and Humanity .. 533
Alkaloids of *Asphodelus microcarpus* 631
Alligator Weed, Occurrence of, in South India 641
Amoebae, Encystment of: An Example of Single Cell Differentiation .. 589
Anabaena variabilis, Structure and Germination of Akinete of .. 142
Angular Correlation Study on the 321–177 keV Casade in ^{125}Te .. 458
Annellophorella (A New) on *Zizyphus* 471
Anotis wightiana, Embryology of .. 606
Announcements: 73, 120, 201, 278, 362, 419, 448, 475, 504, 532, 560
Anthocyanin Development *in vitro* in Tender Internode Explants of *Eucalyptus* 499
— Pigment, Action of, Controlling Genes in *Zea mays* 164
Antibiotics and Imidazole Derivative, Action of, On *Drechslera pedicellata* G. Root Rot Fungus 313
—, Multiple Production of Distribution Pattern 131
Antifungal Vapour Action of VFI Tablets Against Microbial and Seed-borne Pathogens 41

PAGE

Antipyrine, Amidopyrine, Phenylbutazone and Salipyrine, X-ray Crystallographic Study of 262
— Crystal Structure of 489
Antitubercular Agents, Some Hydrazones of 5-Bromo Coumaralic Acid Hydrazides 401
Amino-Acids (Free) of the Haemolymph of *Poecilocerus pictus* during Ovarian Cycle, Studies on .. 563
— — — in the Tissues of *Belostoma indica* 355
Amoeba navina sp., A Large-Sized New Species from Tropical Rivers .. 493
Amphistome Cercaria from *Gyraulus euphraticus* (Mousson) 378
Aphelenchoides Fischer (Nematoda: Tylenchida) An Intersexual Form 519
Aphid Resistance (Induced), in Brassica *juncea* Coss. 311
Apomixis in *Cenchrus ciliaris* .. 444
Apple Fruits, Post-Harvest Chemical Treatment of, Against Rot and Deterioration 387
Arecanut, Tissue Potassium in, A Rapid Method for Determination of 518
Arenicola brasiliencis, Occurrence of, in Ratnagiri 17
Asafoetida, Effect of, On Root Initiation in Bean Plant 139
Aspergilli, Production of Organic Acids by Soil 198
Aspergillus candidus, Toxic Nature of 12
— *flavus*, A Fungal Parasite of *Epilachna vigintioctopunctata* .. 666
Asphodelus microcarpus, Alkaloids of 631
Asphyxia from Congenital Goitre in New-Born Kids 64
Avian Encephalomyelitis 55
— Myeloblastosis Virus Associated Myeloblasts and Chick Embryo Fibroblasts Viral Antigens in .. 81
Avrainvillea nigricans along Indian Coast, Occurrence of 116

BACTERIAL Disease of Indian Honey-Bees, A New 196
— — — Ragi, *Eleusine coracana*, in Mysore State 611
— Leaf Spot Disease on *Heliotropium eichwaldi* due to *Xanthomonas heliotropii* sp. nov. 498

PAGE

Bacterioids at the Site of Nerve Severance in the Cockroach *Periplaneta americana* 606
Bacteriological Activity in Saline, Saline Alkali and Alkali Soils 269
Balanus amphitrite communis, Laboratory Rearing of 109
Basalts, Oxidation of Monodomain Magnetic Grains in, Associated Changes in Magnetic Propeties .. 1
Base Hydrolysis and Aquation of *trans*-Chloropyridinebisdimethylglyoximatocobalt (III) 623
Basic Dykes Sequence in the Precambrian Complex South-East of Tura, Garo Hills, Assam .. 449
Bat, Indian Fruit-, Localized Progestational Endometrial Reaction in the Uterus of 490
Beijerinckia indica as a Nitrogen Fixer of Paddy Crop in Acidic Soils 112
Benstonite, Occurrence of, From the Carbonatite Complex at Jogipatti, Tamil Nadu (Madras) 254
Benzothiazolyl Guanidines as Antibacterials 658
— —, Some New 322
Betafite and Pyrochlore, Studies in the Relationship Between 319
Bibliography of Papers by Sir C. V. Raman Published in *Current Science* 249
Biogeography Seminar at the French Institute, Pondicherry 613
Biological Rhythm, Time Series in .. 63
Bis-Anilinium Hexahalo Zirconates or Hafnate (IV) 189
Bischofia javanica, Chemical Investigation of 11
Bismuth Oxide Molecule (BiO), Dissociation Energy, *r*-Centroids and Franck-Condon Factors of .. 316
Bixin and Methyl Bixin, Preparation of, from Indian Seeds of *Bixa orellana* 27
Blue Green Algae, Solubilization of Tricalcium Phosphate by .. **165**
— — — Tolerance of, to Pesticides 143
Books Received 24, 50, 73, 96, 120, 146, 174, 202, 278, 306, 333, 362, 390, 419, 448, 475, 504, 532, 560, 588, 616, 644, 674
Boseimycin and Streptomycin, Comparative Studies on the Effects of, in *Bacillus subtilis* 440

PAGE

Bromination of Anisole Catalysed by Zinc Chloride and Other Salts .. 83
— — *p*-Nitrophenol, Variable Orders in 10
Bunostomum trigonocephalum, A Method for Isolating Pure Cultures of Juveniles of 665

CADMIUM Acetylacetonate, Reaction of, with Nitrogen Donor Ligands 106
Caesium in Sea-Water, Exchange Capacity of Ammonium Phosphomolybdate for 542
Calcareous Alga from the Kalhel Limestone, Chamba District, H.P. 435
Calcite Cubes, Pseudomorphous, from Koyananagar, Maharashtra, India 37
Callichrous macrophthalmus with a Forked Right Barbel 438
Capacitance and Thickness of Space-charge Sheaths at Plasma-Wall Boundary 261
Capillary Condensation of Water in Proteins 660
β-Carotene in Leaf Proteins .. 293
Carpophore-Inducing Factor from Seedlings of *Vallisneria spiralis* .. 359
Castor Seeds, Reduction in Oil Content of, Due to Storage Fungi .. 273
Cation Exchange Capacity of Roots of the Root-Parasite *Santalum album* 662
Caviunin, The Occurrence of, in *Dalbargia paniculata* 602
Cedrus deodara, Chemical Components of the Stem Bark, of Isolation of a New Dihydroflavonol 464
Cell Cycle Time and Duration of S Phase in Barley 595
Cellulolytic Activity of Marine Fungi 423
Cellulose Powder as Legume Inoculant Base 494
Centipede, Fine Structure of the Tracheae of, *Sculigera longicornis* .. 467
Centrifugation, of Cytogenetical Effects of, on Germinating Wheat Seeds .. 163
Cercariae pigmentata from *Pila globosa,* A Report on the Emission of .. 160
Cercospora citrullina, Occurrence of, on Muskmelon 671
— Leaf Spot of Bajra, A New Record 381
Chaetomium bostrychodes and *C. succineum* Sexual reproduction in .. 357
Chemical Constituents of *Daemia extensa* (Roots) 594

PAGE

Chemical Examination of the Leaves of *Maesa macrophylla* 320
— — *Mimusops hexandra*, Isolation of a New Triterpene .. 654
— Investigation of the Stem Bark of *Hesperethusa crenulata* . .. 570
— Studies of *Psoralea corylifolia* .. 505
Chemico-Genetic Studies of Leucoanthocyanidin in a Maize Mutant .. 335
Chemistry and Pharmacology of Apocynin Isolated from *Picrorhiza kurroa* 603
Chiasma Localization, Breakdown of, in *Allium cepa* . 411
Chickpea, Survey for a High Methionine Variety in the World Collection of . 652
Chloral Hydrate, Identification of in the presence of Formaldehyde from Biological Materials by TLC 190
Chlorine Nuclear Quadrupole Resonance in Certain Organic Solids [illegible]
Chlorophyll and Protein Breakdown in Senescing Leaf Discs of Kale Arrest of, by Cycloheximide and Vanillin . 294
Cholera, Evaluation of Antibacterial and Antitoxic Immunity in . 281
— Research Newer Facets 477
Chromic Acid Oxidation of Acetophenone Mechanism of 84
Chromosome Breakage A Direct Evidence for the Misdivision Hypothesis . 147
— Number (Somatic) of *Rhizopus arrhizus* . 140
Citric Acid Metabolism in the Fruit Tissues of *Citrus acida* 97
Citrus Greening Disease, Isolation and Culture of Mycoplasma Associated with 299
Claisen/Stobbe Condensation a Stereospecific 550
C—N, C—O and C—S Bonds in Amides and Thioamides 565
CO_2 Formation of, in the Microwave Discharge of CO_2 . 397
Cocconia placenta and *Penzigia placenta* Two New Records of Ascomycetes from India . 169
Coenurus Sp. from the Peritoneal Cavity of the Gerbil *Tatera indica* 521
Coins (Paunar), Chemical Treatment, Preservation and Analytical Study 618
Coleus blumei, Effect of Pre-treatment of Leaves of, with Cytokinins .. 19
Colloquium on Micropalaeontology and Stratigraphy 617
Colour Test for the Detection of Sulphite Ion based on Bodeker's Reaction 547
Complexes of Diethanolamine with Ni (II) Salts 629
— 5, 5′-Thiodisalicylic Acid with some d^{10}-Transition Metal Ions .. 600
Congeria sallei Recluz, A Fouling Bivalve Mollusc in Visakhapatnam Harbour 408
Convection Over a Naturally Permeable Bed 451
Copepod Parasite, *Lernaea* sp. nov. on a Cyprinodont Fish *Lebistes reticulatus* 455
Coralloidal Calcite from a Mica Mine in Nellore, Andhra Pradesh . 434
Corynespora Leaf-Spot of Cow Peas . 116
Cotton, Radiation-Induced Photo-Insensitive Mutants .. 583
— *Verticillium dahliae* Wilt of .. 416
Crabs, Indian, Successive Egg-laying without Mating . . 48
Crinkled Leaf Mutation—A Case of Incomplete Gene Penetrance in *Nicotiana tabacum* . 350
Crustaceans from the South West Coast of India, Reproductive Cycle of Three Decapod 161
Crystal Data of an Ammonium Salt of Cyclic Cytidine 2′, 3′ Phosphate . 625
— — a Carbonyl Complex of Ruthenium .. . 265
— — Some Mononucleotides . 544
Crystallographic Studies in the System (1 − X) La_3NbO_7 + X Sm_3NbO_7
Crystal Structure of Antipyrine 389
CuBr Molecule, Rotational Analysis of D-X Band System . 459
Cyanopyridine Vapour Absorption Spectra $^1\Gamma$-$^1\Pi$ Transition in Isomeric 628
2-Cyanopyridine, Microwave Spectrum of 398
Cybister (Coleoptera), Follicular Epithelium of .. . 16
Cycas circinalis, Swollen Roots of . 117
Cyst Forming Nematode Attacking *Sesamum orientale* in India .. 612
Cytochrome Oxidase Activity, Changes in, During Temperature Adaptation of Earthworm *Lampito mauritii* . 664

PAGE

Cytogenetical Investigations Following Centrifugation of Germinating Wheat Seeds 163
Cytological Observations in the Digenetic Trematode *Philophthalmus* sp. from Eagle 578
Cytology of the Madras Mint .. 544

Daemia extensa, Chemical Constituents of the Roots of 594
Dalbergia sissoo, Seasonal Variations in the Size of Cambial Initials .. 114
Debye Parameter and Vibration Amplitude of Sodium 459
Dendrobium macrostachyum, Occurrence of Monosporic and Bisporic Embryo-sacs in 554
Devonian Fossils from the Lesser Himalayan Zone of Central Bhutan.. 490
Diamond, Spectroscopic Studies on, by Raman and his Group 242
—, Studies on the Structure and Properties of 240
Diatom Hemidiscus hardmannianus Significance of Blooms, Occurrence on Hilsa Fishery in Bengal .. 410
Dibenzyl Thiourea (Symmetrical) A New Synthesis of 156
Dielectric Constant of Certain Dihydroxy Solids 62
— — — the System $X\ SM_3\ NbO_7 + (1-X)\ La_3NbO_7$ 400
Dill European (*Anethum graveolens*) Isolation of a New Cultivar of .. 141
— (Indian), Intraspecific Variability in 328
Diploid *Chlorophytum orchidastrum* from Ghana (Africa) 607
— — — Cytotaxonomy of .. 608
Dipole Moments (Electric) of Some Less Studied Aliphatic Amines .. 346
Dissociation Energy, *r*-Centroids and Franck-Condon Factors of BiO Molecule 316
Dolerite Dyke, Magnetization of a, in Jharia Coalfield 480
Dolichos lab-lab, Non-Season Bound, with new Plant-Type 667
— Yellow Mosaic, Effect of, on Chlorophyll and Leaf Proteins 18
'Dye Binding Capacity' Value in Rice, Inheritance of 28
Dynamics of Crystal Lattices .. 227

PAGE

EINSTEIN Coefficient Oscillator Strength and the Lifetime Measurement in PbO Band System .. 32
Elastic Constants and Sub-Harmonicity 233
Electromagnetic Fields, A New Class of 100
Electronmicroscopy of Teliospores of, *M. eleusinis* (Ragi Smut) .. 529
"Elovich Equation, A New Approach to" Comments on the Paper .. 599
Encystment of Amoebae: An Example of Single Cell Differentiation .. 589
End-of Season Breakdown of Self-Incompatibility in *Solanum chacoense* 524
Endothecium in *Pyrostegia venusta* .. 470
Enhydrin, Structure of 267
E.S.R. Studies on Glycine Complexes of Manganese Chloride and Manganese Bromide 309
Estrogen, Effect of, on Tubal Transport of Ova in Rats filled with IUCD 659
Ethmosligmus .spinosus, Pertrophic Membrane of, Electronmicroscopic Study of Ultrastructure 134
Eucalyptus, Anthocyanin Development *In vitro* in Tender Internode Explants of 499
Exchange Capacity of Ammonium Phospho-molybdate for Caesium by Batch Technique 542

FERN—*Hypodematium crenatum,* Morphogenetic Variations in the Gametophyte of a 3 X Rice .. 384
Fixation of Elementary Nitrogen by *Scytonema geitleri* in Pure and Unialgal Cultures 330
Flavonoids of *Millingtonia hortensis* .. 194
— — *Thunbergia grandiflora* and *Asystasia travancorica* 404
Floral Anatomy of *Orygia decumbens* 137
Flow between Eccentric Spheres .. 256
Fluoranthene Derivatives, Synthesis of 463
Fossil Polychaeta from the Cretaceous Rocks of South India 632
—s and Middle Stone Age Tools from Nandur-Madhmeshwar on Godavari River (Nasik District) 13
Franck-Condon Factors and *r*-Centroids for the A-X System of SiH Molecule 625
Free Amino-Acid Content of the Greening Affected and Health Plants of Sweet Orange (*Citrus simensis*) .. 469
— — —s in *Lipaphis erysimi* Kaltenback (Hemiptera: Aphididae) .. 273

PAGE

Fumaria indica, Chemistry and Pharmacology of the Major Alkaloids of 455
Fungal Filtrate with Pronounced Inhibitory Action Against Semliki Forest Virus in Mice 571
Fungicide Dexon, Effect of, on Soil Aggregation 394
Fusarium Wilt on Muskmelon, Occurrence of 171

GALL Midge Resistance in Rice, Nature of 497
Gametophytes of *Cyperus alternifolius* 327
—, Development of Male and Female in *Prinsepia utilis* 7
Gandhi Memorial Lecture—Agriculture, Science and Humanity 533
Gerbil (Indian), *Tatera indica indica* Abnormal Development of Lower Incisors 88
Glucose, Absorption of, in the Gastro-intestinal Tract of Birds .. 159
Glyco-Alkaloid Content of Diploid and Tetraploid *Solanum khasianum* .. 70
Goitre in New-Born Kids, Asphyxia from 64
Grain-Size of Polycrystalline Materials by X-Ray Difraction, Extrapolation Method 627
Gravitational Field of a Tachyon .. 651
"Green Earth", Low Grade Metamorphism of, from Pashan, Poona .. 549
Greening Pathogen of Citrus, Response of, to Certain Tetracycline Antibiotics 552
Green Pigment from the Sub-Epidermal Connective Tissue of *Sipunculus nudus* 574
Groundnut (*Arachis hypogaea*), Relationship between Branching and Flowering Pattern in Cultivated Varieties 438
Growth-Inhibiting Toxic Substance, Production of, by *Alternaria triticina* .. 197
— Requirement (*In vitro*) of Mature Endosperm of *Ricinus communis* .. 337
Guanidines, Substituted Benzothiazolyl 430
Gwalior "Sill" and Kaimur Sandstone, on the Nature of the Contact Between 404

HAEMAGGLUTINATING Activity in Normal Culture Fluid of *Aedes albopictus* Cell Lines 354
Hafnates (IV)—*Bis*-Anilinium Hexahalo Zirconates 189

PAGE

Hafnium Monoiodide, New Band Spectrum of 516
Helminthosporium oryzae, Induced Tolerance of Spores of, to Fungicides 168
Hermaphroditism in the Cat-Fish *Heteropneustes fossilis* .. 407
— — — Ribbon Fish, *Trichiurus lepturus* 520
Herpobasidium Lind., Occurrence of the Genus in India 579
Heterotic Response for Percent Grain Protein and Pelshanky Value in Bread Wheat 413
Hibiscoxylon intertrappeum, Occurrence of, from the Deccan Intertrappean Series 167
Histomorphology of Meckel's Diverticulum in Two Species of Birds .. 634
Honey-Bees *Apis indica,* Occurrence of a New Bacterial Disease of .. 196
Hyalodendron, A New Species of, from India 668
Hybridization in Modern Roses .. 4
Hybrid Rice, Outlook for, in India .. 391
Hydrellia philippina Ferino as a Pest of Rice in Kerala 498
Hydromagnetic Flow Near an Oscillating Wall 486

IDIOFIBROSCLEREID—A Descriptive Term for Wandering Mesophyll Fibres 551
Indian Academy of Sciences—XXXVII Annual Meeting 645
— — — — Abstracts of Papers in Section A 646
Indole Acetic Acid Synthesis and Virulence of Different Races of *Pyricularia oryzae* 113
Induced Ophid Resistance in *Brassica juncea* Coss 311
— Mutations in a Sweet *Capsularis* Jute 584
— Resistance in 'Dular' Variety of Rice Plants Against *Helminthosporium* Infection 501
— Tolerance of Spores of *Helminthosporium oryzae* to Fungicides .. 168
Infectious Bursal Disease in Chickens .. 181
Infrared Spectrum of 2, 3-Difluoroaniline 655
Inhibition of Ascisic Acid Induced Chlorophyll Degradation by Potassium 302

PAGE

Intergeneric Cross in the Cucurbitaceae —(*Coccinia indica* × *Bryonopsis laciniosa*) 46
Intraspecific Variability in Indian Dill 328
Iodine Value of Linseed Oil, Gamma-ray Induced Variability of .. 298
Iron Determination (Total), 1,2-Dihydroxy benzene-4-monochloroacetylate —A Selective Reagent for .. 268
Islet Cytology of *Tringa glareola* .. 325
Isothermal Grain Growth in Strained Commercial 2 S Aluminium .. 566
IUCD, Effect of, on the Urea Content of Uterine Fluid of Rats .. 353
Ixiolite, Structure of 34

JELLY Fish Sting, Note on a Case of Death Caused by, in Gulf of Mannar 637
Jute (*Corchorus olitorius*) JRO-632, Nuclear Instability and Chromosomal Variability in a Promising Strain of 329
— Genetical Studies in Five Radiation-Induced Mutants 500
— Induced Mutations in a Sweet *Capsularis* 584

KAEMPFEROL 3-O Rhamnogalactoside: Revised Structure for a Glycoside in *Gliricidia maculata* Leaves .. 106
K-Conversion Coefficient of 80 keV Transition in 144 Pr. 289
Kinetics of Dehydration of *t*-butanol by Gas Chromatography 318
Klossiella murris, Occurrence of, in the Kidney of a Mouse 110
K-X-ray and Gamma-Ray Angular Correlations in the Decay of ^{153}G.D. and ^{186}R.E. 101

LAMINAR Dispersion of Solute in a Porous Medium, Universal Stability **561**
Languages, the Theory of Formal .. 650
Laser-Excited Raman Spectrum of *Clostridium pasteurianum* Ferredoxin 626
— Raman Spectroscopy of Organic Compounds 239
Lattice Dynamics, Professor Raman and 646
— Thermal Expansion of Lead Tungstate 487
Lead Tungstate, Lattice Thermal Expansion of 487
Leptopharynx chlorophagus (Ciliata: Protozoa) from Freshwater of West Bengal 195

PAGE

Leptynites, Elastic Studies in .. 155
Leucoanthocyanidin, Chemico-Genetic Studies of, in a Maize Mutant .. 335
Leucopelargonidin from *Hydnocarpus wightiana* 187
Light Tracks in the presence of a Massive Body 61
Lignite as a Carrier of Rhizobia .. 496
Limnobiotic Conditions Along a Hot Spring Thermal Gradient .. 491
Limonene Monochloride—Its Nature and Reactions 152
Linseed Oil, Gamma-Ray Induced Variability in the Iodine Value of .. 298
Lithium Formate Monohydrate, PMR Study of 486
Lorentz Matrix, General, and Some Identities 104
L-Shell Photoelectric Cross-Sections for Low Energy Gamma Rays in Lead 129

MAMMALIAN and Reptilian Remains from the Middle Eocene Rocks of Kutch 436
Mammalian Toxicity of Ergot of Bajra 557
Magnetic Properties of Basalts, Oxidation of Monodomain Magnetic Grains 1
— Universe, A Simple 288
Magnetization of a Dolerite Dyke in Jharia Coalfield 480
Maize, Modified Opaque, for Possible Applied Use 581
— Mutant, Chemico-Genetic Studies of Leucoanthocyanidin in 335
—, Specific Locus Mutations in, by Chemical Mutagens 136
Manganese Chloride and Manganese Bromide, E.S.R. Studies on Glycine Complexes of 309
Mango Decline Caused by Cation and Anion Imbalance 356
—, Effect of Growth Retardants on Flowering and Apical Dominance of 388
Marine Environment, Organic Materials in the, and the Associated Metallic Elements 75
— Sediments, Alkaline Earth Elements in, Off Tarapur Coast, Bombay .. 25
— — Dating, U^{234}/U^{238} as a Tool for 279
Megatectonics of Continents and Oceans (Rev.) 31
Meliola juttingii on *Pandanus odoratissimus* from Kerala 527

PAGE

Methyl Angolensate, Identification of, in the Bark of *Soymida febrifuga* 158
Micropalaeontology and Stratigraphy Colloquium 617
Microwave Spectrum of 2-Cyanopyridine **398**
Millet (Pearl), Association of Leaf and Stem Characteristics with Grain Yield 89
Mint (Madras), Observations on the Cytology of 544
Misdivision Hypothesis, A Direct Evidence for 147
Modulation of Electron Waves by Laser Beam 650
Molecular Orbital Studies of Electron Donor-Acceptor Systems .. 483
— Weights of Cholinesterases from the Indian Honey Bee and the Desert Locust 369
Monazite and Zircon, Leaching Patterns of 14
Morphactin and Cytokinins Interaction in Seedling Growth of *Ruellia tuberosa* 93
—, Effect of, on Leaf Morphology and Tendril Formation in *Momordica charantia* 140
Multinucleate Pollen Mother Cells in *Triticales* 301
Mutational Analysis of a Locus Governing Brittleness in *Oryza sativa* 286
Mycoplasma Associated with Citrus Greening Disease, Isolation and Culture of 299

NEMATODE Populations in Rice Soils, Optimum Sampling Time for Assessment of 17
Neutron Diffraction Study of Triglycine Sulfate 60
Niacin Inhibition of Root Growth in Lattuce Seedlings 40
Nicotinamide Requirement of a Strain of *Fusarium vasinfectum* Atk. .. 553
Nitrogen Afterglow, Effect of O_2 on 365
— Fixation by *Scytonema geitleri* in Algal Cultures 330
— Fixing Bacteria from Saline Alkali Soils, Suitability of Carbon Sources for the Enrichment of 124
— in Steel, A Simple Device to Improve the Estimation of .. 266
— Mineralization in Organic Manures, Retarding Effect of Desiccation on 158

PAGE

NMR Investigation of Molecular Association in Liquids 656
NMR Study of Spin-Lattice Relaxation and Molecular Association in Organic Solutions 264
Nomenclatural Revision of Common Rust Fungus Affecting Sugarcane .. 42
Non-Linear Vibration of Stretched Strings 244
— Season Bound *Dolichos lab-lab* with New Plant-Type 667
Normal Coordinate Analysis of N, N-Methylthiopropionamide .. 421
Nose, Structure of the, in Some Indian Teleostean Fishes 550
Nostoc linckia, A Strain of, unable to Use Molecular Nitrogen .. 67
NO_2^-, Structure of 187
Nucleic Acid and Protein Synthesis in *Azotobactor chroococcum*, Effect of Antibiotics on 43
— — Gallocyanin Reaction, Studies on 344
Nutrition Congress 103

OIL-BODIES in South Indian Liverworts 638
Oocytes, Occurrence of, in the Kidney of the Cat-Fish *Heteropneustes fossils* 604
Optical Bleaching of X-Ray Irradiated NaCl Crystals 511
Optics of Heterogeneous Media .. 648
— — Polycrystalline Minerals .. 649
Organic Acids, Production of, by Certain Soil *Aspergilli* 198
Ordovician Fossils from the Baramula District, Kashmir 466
Organic Materials in the Marine Environment and the Associated Metallic Elements 75
Organo-Sulphur Compounds: Diesters of Sulphurous Acid 462
Orygia decumbens, Floral Anatomy of 137
Oxidation of Fluren-9-ols by Cr (VI) 348
Oxygen Tension, Effect of, on Respiration in *Rana tigrina* 469
Oxymercuration-Demercuration of Acetylenes 400

PALAEOMAGNETISM and the Continental Drift 572
— — Multiple Intrusion .. 406
Palm Leaf from the Deccan Intertrappean Series, Mohgaon Kalan (M.P.), India 526

PAGE

Papaya, A New Fruit Rot of, Caused by *Phomopsis caricae papayae* .. 612
Parioglossus (Teleostei: Gobioidea), Systematic Position and Occurrence of, in Indian Waters 339
Parthenium Weed in Mysore State and Its Control 568
Paunar Coins, Chemical Treatment, Preservation and Analytical Study .. 618
Pearl Millet, Triple Trisomic in .. 22
Pediment Survey to the North of Coimbatore in South India .. 376
Penicillium citrinum Toxicity, Some Observations on 373
Phase Studies in the System BiMoO$_6$—La$_2$ MoO$_6$ 154
— — — — — — Fe$_x$ Ca$_{(1-x)}$ Nb$_2$O$_6$ 345
Phenol-Formaldehyde Reaction Products, Separation of, by Reserved Phase Chromatography 156
Phenolic Components of Bombay *Malabaricum* (Root-Bark) .. 630
Phenolic Constituents in Wheat Grains 414
Phenylhydrazine, Effect of, on Glucose-6-Phosphate Dehydrogenase Levels in Rice Moth Large 107
Phosphate, Occurrence of in Aru Vallty, Kashmir Himalaya 38
Photodecomposition of Azidopentammine and Diazidotetrammine Cobalt (III) Complexes 598
Phyllosticta, An Undescribed Species of, from Maharashtra 444
Physalis minima and *P. Peruviana* Bitter Principles of 85
Phytochemical Study of *Argemone mexicana* Linn. Latex 548
Phytotoxic Behaviour of Metabolic By-Product of *Nigrospora oryzae* on Some Varieties of *Oryza sativa* .. 166
γ-Picoline Complex of Copper (II) Iodide 599
Pineapple Variety Kew, Chemical Weed Control in 296
Piperazine Ethanol Acrylates, Synthesis of, as Possible Antiphlogistics and Analgesics 464
Plant Remains in the Phyllites of Bhikiasain Area, Almora, Uttar Pradesh 377
Pleistocene Deposit Around Ariyalur, Madras 37
Poecilocerus pictus (Acridae), Studies on the Free Amino-Acids of the Haemolymph of 563
Pollen Dimorphism in *Wedelia biflora* 44
Polyphenols of the Seedcoat of *Mangifera indica* 157
Porous Electrode Operations, Theory of 175
Potato, Germination of True Seeds Under Long Storage Conditions .. 379
Precambrian Complex in Garo Hills, Meghalaya, Assam 449
Pregnane Derivatives of *Marsdenia volubilis* 193
Prenylamine (Segontin), The Effect of, on Smooth Muscles 192
Preservation of Plant Specimens, A New Laboratory Technique 66
Prinsepia utilis Royle, Development of Male and Female Gametophytes in 7
Protein Determinants in Bread Wheat, Correlation Between Some Quality Characters and 150
Photon Magnetic Resonance Study of Lithium Formate Monohydrate 486
Psoralea corylifolia, Chemical Studies of 505
Pyrenochaeta, An Undescribed Species of, on an Economic Host .. 169
Pyricularia on Barley 170

QUINOLYLAZO-4-Phenanthrol (QAP) and its Metal Chelates 352

RADIATION-Induced Photo-Insensities, Mutants in Cotton 383
Raman, Sir Chandrasekhara Venkata, N. L., The Years Preceding the Discovery of the Ranan Effect .. 203
— and Astronomy 217
— — the Colour of the Sea .. 224
— as a Teacher at Bangalore .. 222
— — I knew Him 221
— — a Meteorologist 219
— — — Man of Science and his Interest in Geology 211
—, Bibliography of his Papers Published in *Current Science* 249
— Effect 207
— on the Raman Research Institute 248
—, My Professor 234
—Nath Theory 235
— Research Institute Director .. 514
Raman's Contributions to Spectroscopy 237
— Gift to Our Nation 209

PAGE

Raman's Interest in Meteorology ... [illegible]
— Some Reflections on [illegible]
Raman Spectra of Acenaphthene [illegible] Acenaphthene-d_{10} [illegible]
Raman's Work on the Dynamics of Vibrations ... [illegible]
—, The Artist Scientist [illegible]
— "Scientist Savant" [illegible]
— Unique Mentor [illegible]
Rate Coefficient for Two-Body [illegible] Recombination [illegible]
Repugnatorial Gland Secretion [illegible] of, on the Oxygen Consumption [illegible] Millipede ... [illegible]
Restricted Random Mating: A New Mating Model [illegible]
Reviews and Notices of Books [illegible] 119, 145, [illegible] 200, [illegible] 301, 389, [illegible]
Rhizobium, Composite Cultures of, as a better means of Increasing Yield of Soybeans ... [illegible]
Ribonuclease Activity of [illegible] radiatus Seedlings, [illegible] 8 Azaguanine on [illegible]
Rice, A Method of Inducing [illegible] Condition by Chemical M[illegible]
— Bacterial Leaf Blight of, A New Indian Host of [illegible]
— 'Dye Binding Capacity' Value, Inheritance of
— Effect of X Irradiation on Growing Embryos in [illegible]
— Foliar Spray of Urea for Yield Increase [illegible]
— Hoppers, Some New Records of, in Maharashtra [illegible]
— Moth Larva, Effect of Phenylhydrazine on the G-6-PDH Activity of ... ... [illegible]
— Nutritional Quality of Some Popular Varieties ... [illegible]
— (*Oryza sativa*), Mutational Analysis of a Locus Governing Brittleness in 286
—, Outlook for Hybrid, in India [illegible]
— Plants, Induced Resistance Against *Helminthosporium* Infection [illegible]
—, Primitive and Current Cultivars of, in Assam, A rice Source of Valuable Genes [illegible]
— Protein Content of, Effect of Fertilizer on ... [illegible]
Ricinus communis, *In vitro* Growth Requirements of Mature Endosperm of [illegible]

[illegible]

Semen (Human), A New Colour Reagent for the Detection of Acid Phosphatase in [illegible]
Sex Dimorphism in the Bombardier Beetle *Pheropsophus* [illegible] [illegible]

PAGE

Sexual Dichromatism in the Puffer Fish, *Chelonodon cutcutia* 39
— Dimorphism in Indian Freshwater Goby, *Glossogobius giuris* .. 65
— Gynandromorphism in *Bufo melanostictus* 577
— Reproduction in Two Species of *Chaetomium* 357
Silica Cells in the *Cyperaceae*, Abnormal Position of 525
Silver-Silver Selenocyanate Electrode .. 292
Simazine, Effect of, on the Fodder Production of M.P. Chari (*Sorghum bicolor*) 641
Soil Aggregation, Effect of Fungicide Dexon 394
—Based Irrigation for Maximisation of Crop Yields with a Given Unit of Water 179
— Fertility in the River Narmada Upper Catchment Area 375
Solanum chacoense, End-of-Season Breakdown of Self-incompatibility 524
— *khasianum*, Glyco-Alkaloid Content of Diploid and Tetraploid .. 70
Solar Radiation—Induced Mutations in *Aspergillus* 583
Solubilization of Tricalcium Phosphate by Blue Green Algae 165
Solution Properties of Poly Butyl Acrylate and Poly Butyl Acrylate Co-styrene 32
Spacecharge Sheath at Plasma-Wall Boundary Capacitance and Thickness of 261
Spherically Symmetric Metric of the Geodesic Type, Some New Results 515
Spin-Lattice Relaxation and Molecular Association in Organic Solutions, an NMR Study of 264
Sporulation Studies on *Cercospora personata* Suitability of Glassware in 45
Stability of a Heterogeneous Conducting Fluid with Coriolis and Radial Graviational Force 343
Stalked Ovary, A New Mutant in Barley Induced by EMS 557
S-Tectonite Fabric as a Means of Interpreting Slip Movement and Folded Structure 284
Stereospecific Claisen/Stobbe Condensation 350

PAGE

Steroid Hormones, Effect of, on the Blood Constituents of *Rana hexadactyla* and *Calotes versicolor* .. 297
Stratospheric Dust, Interesting Evidence for, From Electrical Conductivity Measurements 290
Streak Disease of Bajra (*Pennisetum typhoides*) in India 272
Streptococcus pluton, Occurrence of, In Indian Honey-Beas 196
Strontium Bromide (SrBr) Molecule, New Electronic Transitions in .. 317
— Iodide SrI, The Spectrum of, in the Photographic Infrared 186
Succinylcholine and Synaptic Transmission in the Cerebral Cortex .. 191
Sugarcane Rust Fungus, Nomenclatural Revision 42
Sulphuric Acid, Occurrence of Free, in *Spathoglossum asperum* 295
Sylveterpin (±) and *m*-Cineole .. 348
Symbiosis between Cluster Clover and *Rhizobium trifolii*, Effect of Tryptophane on 416
— in Species of *Amaranthus* .. 111
Synthesis of 2, 1-Benzisothiazole .. 351
— — 7, 14-Disubstituted Acenaphtho (1, 2-*k*) Fluoranthenes 546
— — β-1-Naphthylalamine and β-(9-Phenanthryl-Alanine 350
— — γ-Pyronochromanones .. 353
— — Substituted Azoxy-Benzenes .. 402

TEAK (*Tectona grandis*), Is it a Calcicole ? 324
Teleostean Fishes, Structure of the Nose in Some Indian 550
Teliospores of *Melanopsichium eleusinis*, Electron Microscopy of 529
Temperature and Salinity Structure of the Sea Off Waltair at the Commencement of 'Sinking Season .. 573
Tetraploid Chromosome Number in the Genus *Spilanthes* 527
Theory of Formal Languages .. 650
Th/U Ratio as an aid in Prospecting for Diamonds in Kimberlitic Rocks of India 663
Thioanthranil (2, 1-Benzisothiazole), a Novel Synthesis of **351**
Thiodisalicylic Acid 5, 5'-, Complexes of, with Some d^{10}- **Transition Metal** Ions 600

PAGE

Thiourea Derivative from the Seeds of *Salvadora oleoides*, Constitution of 267
Time Series in Biological Rhythm .. 63
Tissue Analysis as an Aid in Assessing Nitrogen Requirements of Cotton 582
Tissue Respiration of Some Thermo-Conformers, Effects of Starvation on 636
Tobacco, *Nicotiana tabacum*, Crinkled Leaf Mutation in 259
Tomato, A Storage Rot of Fruits Caused by *Geotrichum candidum* .. 415
Transferrin (New) Type S in Sheep 661
Transport of Indoleacetic Acid in Bean Cuttings in Relation to Root Formation 422
Trichogrammatoidea sp. as a Parasite of the Sciomyzid Fly *Sepedon sauteri* 523
Trichothecium roseum, Mycoparasitic on *Cercospora Elamea* 303
Triploid *Jasminum grandiflorum* L., A Study of 555
Trivalent Metal Complexes of O Hydroxy Ketoximes .. . 547
Tropical Ecology, Symposium on 184
Truncated Exponential Populations Distribution of Means of Samples from 430
Tryptophane, Effect of, on Symbiosis between Cluster Clover and *Rhizobium* .. . 116
Tungstate Veins, Mineral Assemblage in 87
U^{234} U^{238} as a Tool for Dating Marine Sediments .. . 290
Ultrasonic Absorption Around the Critical Region in *n* Hexane O Toluidine 104
Interferometer with Piezoelectric Ceramics . 546
Studies in Fatty Acids . 572
Universal Stability of the Laminar Dispersion of Solute in a Porous Medium . .. 561
Uranyl (VI) Complex of Coumarin Derivatives, Spectral and Magnetic Studies on 396

Vanda roxburghii, Anti Inflammatory Principles of .. . 86

PAGE

Vat Dyes, Orientation of, in Cellophane on Soaping Treatment 372
Vertebrate Fossils, Discovery of, from the Kargil Basin, Ladakh (Kashmir) 633
Verticillium dahliae Wilt of Cotton .. 416
Vibration Bands, A Method of Assigning by Progressive Isotope Exchange 129
Vibrational Spectra and Normal Vibrations of N Methylthioacetamide .. 620

WADHWAN Formation of Saurashtra 433
Water Hyacinth, Eradication and Utilization of, ... 51
—— 148
—— 367
Wheat (Bread), Heterotic Response for Per Cent Grain Protein and Pelshanky Value 413
Grains, Phenolic Constituents in 414
, On the Sweetness of Whole Wheat Meal 381
Wilt and Stemburn Disease of *Tephrosia vogelii*, Occurrence of, in India 442
Wood Borers, Marine, Two New Records from Bombay Waters .. 199

Xanthomonas heliotropii sp. nov., A Bacterial Leaf Spot Disease on *Heliotropium eichwaldi* .. 498
malvacearum, Pectic and Celluloytic Enzymes of 21
oryzae, A New Indian Host of Incitant of Bacterial Leaf Blight of Rice 271
X ray Crystallographic Study of Antipyrine, Amidopyrine, Phenylbutazone and Salipyrene 262
Study of Cold Work and Recovery in Tungsten 307
Xylaria apiculata Cooke, New to India 443

YOLK Nucleus of Balbiani in Indian Freshwater Goby, *Glossogobius giuris* 575
Yttrium, Thorium and Uranium Salicylaldehyde Complexes, Studies on 432

CURRENT SCIENCE

Fortnightly Journal of Research

Issued on the 5th and 20th of each month

IMPORTANT NOTICE TO SUBSCRIBERS OF THE JOURNAL

As you are aware, CURRENT SCIENCE has been coming out regularly on the due dates as above. With the popularity of the Journal and the increasing scientific activities in the country, there has arisen a greater demand on the space of the Journal for publication of original research. To meet this demand the Working Committee of the Current Science Association has decided to increase the number of pages of the Journal by about 50 per cent, with effect from January 1972.

Due to sharp rise in the cost of quality paper, printing charges and the increase in the postal rates, it has ceased to be possible for the Working Committee to run the Journal with the present rate of subscription. Therefore, it has been decided to enhance the annual subscription for institutions with effect from January 1972 to: India Rs. 48/–; Foreign £ 5·00 and $ 12·00; subscription rate for individual subscribers will remain the same as now.

The continued co-operation of our subscribers is requested.

Bangalore–6
20*th December* 1971

S. R. S. SASTRY
Manager
Current Science Association

INFORMATION TO CONTRIBUTORS

CURRENT SCIENCE is the Premier Science Fortnightly of India published by the Current Science Association, Bangalore and issued on the 5th and 20th of each month. All material intended for publication in CURRENT SCIENCE and books for review should be addressed to the Editor, *Current Science,* Raman Research Institute, Bangalore-6.

The following types of scientific communications will be considered for publication in *Current Science*: (1) Review Articles on topics of major current interest, not exceeding 4,000 words or 12 pages of foolscap; (2) Original Research Papers not exceeding 2,000 words, (3) Letters not exceeding 700 words; (4) Short scientific notes not exceeding 200 words. Articles and papers should include a short abstract at the beginning.

Manuscripts should be typewritten in double space on one side of the paper, carefully revised by the authors and in final form for printing. Illustrations should be minimum in number, drawn in black and white with Indian ink on bristol board, and preferably enlarged to about twice the size they are intended to appear in print which will be mostly in column size.

Business correspondence, remittances, subscriptions, advertisements, reprints, exchange journals, etc., should be addressed to the Manager, Current Science Association, Raman Research Institute, Bangalore-6.

Subscription Rates :

Institutions :	**India Rs. 48·00 ;**	**Foreign £ 5.00 ;**	**$ 12.00**
Individuals :	**India Rs. 24·00 ;**	**Foreign £ 3.50 ;**	**$ 8.00**

THE BANGALORE PRESS

OXIDATION OF MONODOMAIN MAGNETIC GRAINS IN BASALTS AND ASSOCIATED CHANGES IN MAGNETIC PROPERTIES

C. RADHAKRISHNAMURTY, P. K. S. RAJA* [illegible]
Tata Institute of Fundamental Research [illegible]

INTRODUCTION

A FEW years ago the changes taking place in the magnetic hysteresis of basalts on heat treatment have been reported.[1] But a satisfactory explanation could not be given due to lack of data on their basic magnetic properties and complex granulometry. However, in recent years simple techniques[2,3] have been developed for the study of all the magnetic properties and to separate basalts possessing any required grain size distribution of the magnetic mineral, all of which led to a better appreciation of their magnetic character. Moreover, the oxidation mechanisms of magnetite (Fe_3O_4) on heating have been thoroughly investigated,[4,5] the results of which have a direct bearing in understanding the magnetic properties of basalts which mainly contain magnetite or titanomagnetic grains. The most important feature of the oxidation mechanism is its dependence on the grain size. It is conclusively proved[4] that the end product of oxidation is maghemite $(\gamma\text{-}Fe_2O_3)$ when the magnetite grains are less than 1500 Å in radius, whereas it is hematite $(\alpha\text{-}Fe_2O_3)$ if larger grains are used. There is also the possibility that oxidation may not be complete, in which case the process gives rise to magnetite grains with a protective coating of hematite by 'disproportionation' of the intermediate cation deficient phase. The magnetic properties of these iron oxides are quite different from one another and hence they could be distinguished by simple magnetic studies. Also it can be shown that the peculiarities of oxidation of magnetite are responsible in many cases for the changes in the magnetic properties of basalts on heating.

EXPERIMENTS AND RESULTS

The magnetic properties of basalts investigated in the present study are the thermal variation of low field susceptibility (k) and high field (1000 oe) magnetization J_s and hysteresis in different fields and temperatures.

In Fig. 1, the $k(T)$ and $J_s(T)$ curves for the specimen 243 and its hysteresis loops in [illegible] before and after heating [illegible] are given. It has been reported in a recent paper that the [illegible] 8µ to 20 [illegible] grains. The [illegible] of 243 gives [illegible] ratio M_r/M_s a value close [illegible] where M_r and M_s are the remanent [illegible]

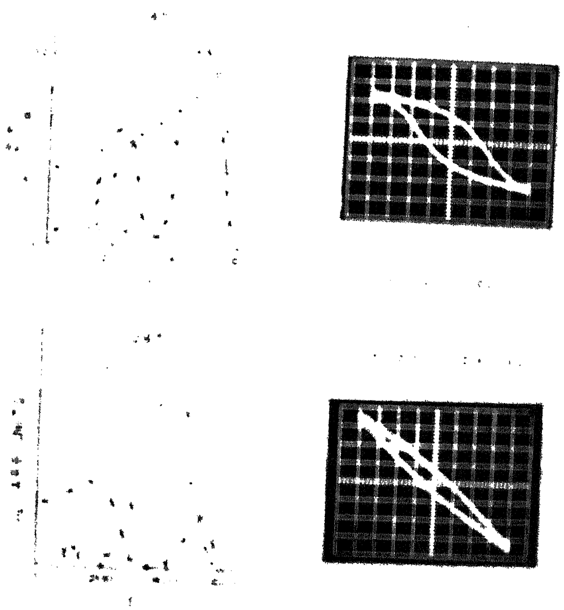


FIG. 1. $k(T)$ and $J_s(T)$ [illegible] and hysteresis loops [illegible] a basalt which changes [illegible] heating [illegible] and d, x axis (magnetic field [illegible]) y axis (magnetic moment [illegible]) [illegible] 0·15 [illegible] and 0·21 for d.

moments respectively. A basalt [illegible] gives a remanence value close to 0·5 for the major as well as all minor loops. The value 0·5 for M_r/M_s where M_s is the saturation magnetic moment is characteristic of a random distribution of monodomain grains in a non-magnetic matrix.[7] The magnetic behaviour of 243 can be explained by the presence of a range of monodomain grain sizes whereby the rock shows pseudo-saturation effects at all fields in which hysteresis is observed. On heating, however, this monodomain character changed (Fig. 1 d) which could be due to the formation of some multidomain grains either of the original mineral or of a different mineral. The second peak in the $k(T)$ and $J_s(T)$

---

* Physics Department, University of Nairobi, Kenya ; now on study leave at the Tata Institute of Fundamental Research.

curves could be due to oxidation and/or grain growth.

In Fig. 2, curves depicting the changes taking place in J_s on repeated heat treatments are given.

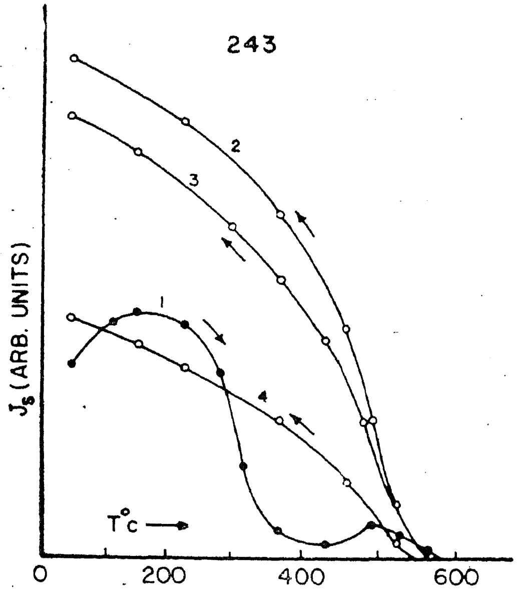


FIG. 2. Heating and cooling J_s curves after different heat treatments. 1 and 2 are first heating and cooling curves respectively. 3 and 4 are cooling curves on heating the specimen at 700° C. for ten minutes and one hour respectively.

Figure 3 shows high field hysteresis loops of the specimen at 25° C. and − 190° C. in its virgin state and after different heat treatments. It is very interesting to note that for the virgin specimen the coercive force (H_c) increases considerably at − 190° C. and also the M_r/M_s value approaches the theoretical[10] value of 0·83 which is again characteristic of a random distribution of monodomain grains with a dominant positive magnetocrystalline anisotropy. It is well known that for magnetite[11] as well as for titanomagnetite,[12] the crystalline anisotropy constant becomes positive and attains a large value at low temperatures. Thus, it is conclusively proved that the specimen 243 contains monodomain grains, though it would be difficult to decipher whether they are of pure magnetite or some titanomagnetite. In any case, on heating, the titanium is bound to evolve and the resulting magnetite may get oxidized.

After the first heating and cooling J_s increased (curve 2, Fig. 2). At this stage, M_s also is considerably large (Fig. 3 *b* I) and the remanence ratio is fairly close to 0·5. But it is important to note that there is very little change in the hysteresis loop (Fig. 3 *b* II) at − 190° C. The loop at 25° C. is that of monodomain grains with uniaxial anisotropy, but the low temperature loop implies that there is no dominance of magneto-crystalline anisotropy. Such behaviour is typical of maghemite as was reported by earlier investigators.[13] In fact, the hysteresis loops of the specimen at this stage are very similar to those of about 1 m. length of half inch wide modern magnetic recording tape which contains monodomain needles of maghemite.

The hysteresis loops obtained for the specimen after baking for one hour at 700° C. are shown in Figs. 3 *c* I and *c* II. The M_m is reduced considerably and there is a very small difference between the loops at 25° C. and − 190° C. Also, the loop at 25° C. shows a little constriction. The reduction in intensity may be due to most of the meghemite of the earlier stage changing into hematite.

It is very difficult to explain completely the hysteresis behaviour of the baked specimen as it may contain all the three iron oxides with possible lattice strains in them due to incomplete oxidation.

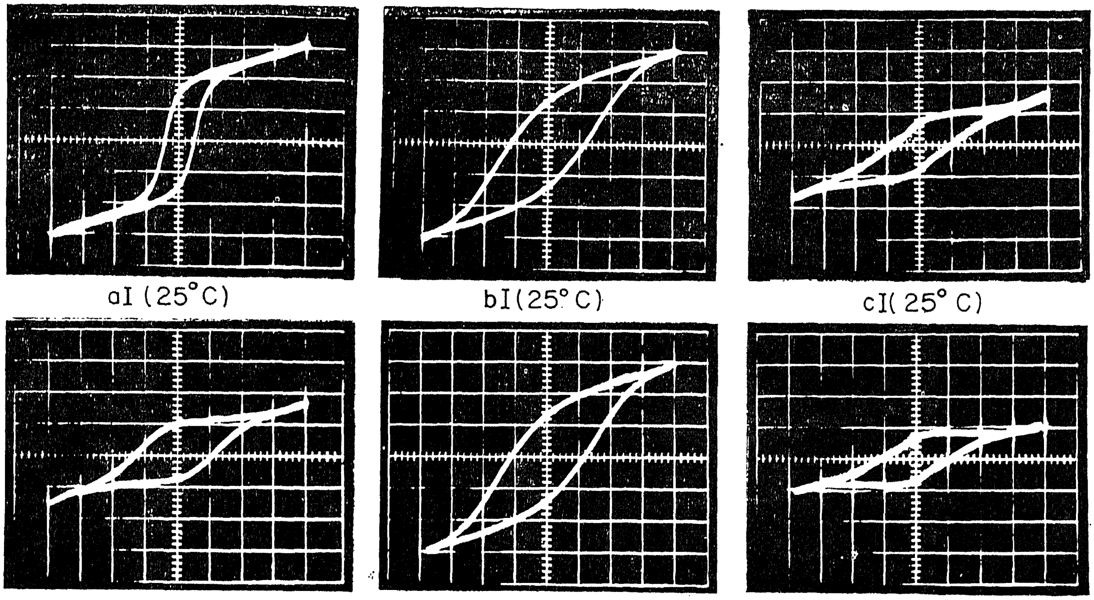
It should also be noted that for all the above stages, the Curie temperatures (T_c) as obtained from J_s (T) curves (Fig. 2) are between 500 and 600° C. which may imply impurities in the oxides.

DISCUSSION

It has been pointed out[1] that drastic changes in magnetic properties occur on heat treatment of fine grained and some altered basalts. Most of such rocks contain monodomain grains as could be deciphered by hysteresis studies. Also, taking the temperature at which a susceptibility peak occurs as the blocking temperature (T_B) and assuming the composition of the grains, their size could be calculated using the relation derived by Neel.[14] Assuming that the grains in 243 have uniaxial anisotropy and T_B of 250° C., they will have a radius of about 85 Å if pure magnetite and somewhat smaller if titanomagnetite. For the same T_B maghemite grains may be about 100 Å in radius. It should be mentioned here that different theories give different values for the critical grain sizes and the one given by Nagata[15] has been used here.

In the virgin state the grains in 243 must be magnetite or titanomagnetite, but not meghemite as magneto-crystalline anisotropy dominates the hysteresis at low temperatures. The shift in T_B from 250° C. to 550° C. (Fig. 1 *a*) on first heating and cooling implies definite grain growth apart from other chemical changes.

It is certain that oxidation[8] of monodomain magnetite grains gives monodomain maghemite. The hysteresis study of this stage (Fig. 3 *b* I and *b* II) reveals predominantly monodomain grains which are very likely to be maghemite. The radius of the grains at this stage should be of the order of 120 Å as computed from the shifted T_B. It is possible that larger monodomain grains might have been formed, but it is difficult to decipher this because of the proximity of T_B to T_C.



aI (25°C) bI (25°C) cI (25°C)

aII (-190°C) bII (-190°C) cII (-190°C)

FIG. 3. High field hysteresis loops of the specimen after repeated heating and cooling; *a* I, *a* II—virgin specimen, *b* I, *b* II—after heating for ten minutes at 700° C.; *c* I, *c* II—after heating for one hour at 700° C. Scale X-axis, one s.d. = 62·5 oe for *a* I, *a* II, *b* I and *b* II and 100 oe for *c* I and *c* II. Y-axis, one s.d. = 0·42 emu for *a* I and *a* II, 1·37 emu for *b* I and *b* II and 0·61 emu for *c* I and *c* II.

The above studies clearly indicate that it is difficult to determine the intrinsic Curie temperature of any magnetic material in the form of monodomain grains occurring in rocks, as heating would produce changes due to oxidation and grain growth. The few observations[2] of nearly reversible *k*(T) curves of basalts would have to be explained as due to little oxidation and negligible grain growth owing to some special environment of the original magnetic grains.

CONCLUSIONS

1. The drastic changes occurring in the magnetic properties of basalts on heating can be accounted by oxidation of monodomain grains and their growth.

2. The monodomain magnetic material in any basalt can often be identified by hysteresis studies at different temperatures.

ACKNOWLEDGEMENT

We thank Professor D. Lal for his kind interest and encouragement throughout this work.

---

1. Radhakrishnamurty, C. and Sahasrabudhe, P. W., *Curr. Sci.*, **1965**, **34**, 474.
2. — and Likhite, S. D., *Earth Planet S.i. Lett.*, 1970, **7**, 389.
3. — and —, *Ibid.*, 1970, **9**, 294.
4. — and —. *Curr. Sci.*, 1970, **39**, 315.
5. —, — and Sastry, N. P., *Phil. Mag.*, 1970 (In press).
6. Colombo, U., Fagherazzi, F., Gazzarrini, F., Lanza vecchia, G. and Sironi G., *Nature* (Lond.) **1964**, **202**, 175.
7. Gallagher, K. J., Feitknecht, W. and Mannweiler, *Ibid.*, 1968, **217**, 1118.
8. — and —, *Ibid.*, 1970, **228**, 548.
9. Stoner, E. C. and Wohlfarth, E. P., *Ibid.*, 1947, **160**, 650.
10. Gans, R., *Annln. Phys.*, **1932**, **15**, 28.
11. Bickford, L. R. Jr., *Phys. Rev.*, **1950**, **78**, 449.
12. Syono, Y. and Ishikava, Y., *J. Phys. Soc. Japan*, **1964**, **19**, 1752.
13. Morrish, A. H. and Watt, L. A. K., *J. Appl. Phys.*, **1958**, **29**, 1029.
14. Neel, L., *Adv. Phys.*, **1955**, **4**, 233.
15. Nagata, T., *Rock Magnetism*, Maruzen, Tokyo, **1961**, p. 25.

HYBRIDIZATION IN MODERN ROSES

PUSHPA LATA

National Botanic Gardens, Lucknow, India

ABSTRACT

Diallel crosses among six strongly fragrant hybrid tea varieties of garden roses possessing flowers of pink and crimson colours revealed that these tetraploid varieties are mainly self-incompatible type. A good amount of seed set was observed in all inter-varietal crosses excepting in Gruss an Coburg which was highly female sterile. Stratification of seeds before sowing in October greatly facilitated germination and better establishment of plants thus making them more suited to stand against the prevailing high temperature during summers. The inheritance of fragrance did not follow a definite pattern as its expression is governed by the ultimate effect of many genes; therefore, considerable decrease or increase in intensity of fragrance was noticed in some of the hybrid flowers. The pink flower colour dominated over the crimson.

INTRODUCTION

PRESENT-DAY garden varieties of roses possess a highly heterozygous combination of characters on account of the role played by hybridization, mutation and a long selectional history. Maximum number of varieties with most of desirable character combinations are available in hybrid tea roses, but still a quest for perfection goes on among the breeders (Pal, 1966; Klimenko, 1969). Detection of strongly-scented seedlings from a cross between poorly-scented parents (Kordes, 1955; Klimenko, 1969) and *vice versa*, accompanied with a variation in quality of fragrance has drawn the attention of many rose breeders from a very long period but the nature and inheritance of this character has not yet been understood. Most of the cultivated roses show a marked decline in pollen fertility on account of extensive structural hybridity (Shahare and Shastry, 1963) operating at pollen meiosis which makes the material more difficult for hybridization experiments. The present investigations were conducted with the aim to study the extent of self-incompatibility, intervarietal crossability, pollen and seed sterility and inheritance of colour and fragrance in hybrid flowers.

MATERIALS AND METHODS

Six strongly scented H.T. varieties, namely, Aroma, Charles Mallerin, Crimson Glory, Edward Mawley, Gruss an Coburg and Hadley were selected owing to their good fruit setting habit. A preliminary survey on their pollen fertility and male meiosis was made to further facilitate the breeding programme. The anthers were fixed in Carnoy's fluid for cytological observations and later transferred to acetic alcohol (1 : 3), previously mordanted with iron. Observations on pollen stainability and meiosis were made with the help of aceto carmine stain. Shrivelled, unstained and empty grains were considered as sterile. For hybridization, flower-buds were emasculated on the previous evening before anthesis and equal number of these were bagged for pollen. Pollen was applied over stigmatic heads the next day which were again bagged. Bags were removed after the stigmatic heads had turned brown or black and thus completely lost their receptivity. Fully ripe rose hips were collected approximately 4 to 6 months after pollination.

Freshly-harvested fruits were kept in a refrigerator at 8 to 10° C. for 150 days. Seeds were sown in two lots in sterilized soil after applying Agrosan G N powder over their surface. The first lot of seeds was sown in the last week of October (1967) and the other in the first week of January (1968). Observations were made on seed germination, growth of seedling, date of flowering and type of flower produced.

OBSERVATIONS

All the varieties included in the present experiment were tetraploids (unpublished data) and produced flowers of pink or crimson colour. The average pollen fertility in the varieties varied from 19 to 36% during the winter season (Table II).

Fruit set was either absent on selfing or was occasional and poor as in Hadley and Aroma where only one cross in each was successful out of 4 and 5 made, respectively. These seeds did not germinate (Table I). In Charles Mallerin fruit set was observed in three cases out of five; two seeds of which germinated (Table I). One seedling of Charles Mallerin was successfully raised which produced flowers of parental colour and fragrance but they were smaller in diameter and consisted of fewer petals.

y good fruit set was observed in all ietal crosses (Table I) excepting in imson Glory with Aroma. The an Coburg showed exceptionally (8·7%) as eight crosses with - resulted only five seeds which germinate. No fruit set was seen in any other cross of Gruss an Coburg. The fruit set was 63·6% in Charles Mallerin and Aroma. Highest percentage of fruit and seed set was recorded in Edward Mawley, *i.e.*, 71·4% and 17·3% respectively. Hadley and Crimson Glory acquire intermediate position with regard to fruit set (Table II).

TABLE 1

♂ / ♀	AROMA	CHARLES MALLERIN	CRIMSON GLORY	EDWARD MAWLEY	GRUSS AN COBURG	HADLEY
AROMA	○○○● $\frac{0}{21}$	●● $\frac{2}{20}$	○○○● CRIMSON $\frac{2}{40}$	● CRIMSON $\frac{5}{30}$	○● PINK $\frac{6}{27}$	●● CRIMSON $\frac{4}{30}$
CHARLES MALLERIN	○○● $\frac{0}{20}$	○○●● ○ CRIMSON $\frac{2}{60}$	○●●● CRIMSON $\frac{2}{40}$	●●● CRIMSON $\frac{3}{30}$	○○● $\frac{0}{11}$	●●●● ○○ $\frac{0}{40}$ ●
CRIMSON GLORY	○○○	○○● CRIMSON $\frac{3}{35}$	○○○○ ○	● CRIMSON $\frac{9}{35}$	○○● $\frac{0}{19}$	○○● CRIMSON $\frac{2}{30}$
EDWARD MAWLEY	○●● $\frac{2}{28}$	●● CRIMSON $\frac{4}{21}$	○○● CRIMSON $\frac{4}{23}$	○○○	●●● PINK $\frac{7}{29}$	○●● CRIMSON $\frac{5}{26}$
GRUSS AN COBURG	○○	○○○○ ○	○○●● ○○○○ $\frac{0}{5}$	○○○○	○○○	○○○○
HADLEY	○● $\frac{1}{30}$	○○●● ○ CRIMSON $\frac{1}{25}$	○●●● ○ CRIMSON $\frac{5}{47}$	● $\frac{0}{5}$	○●●● ○○ PINK $\frac{8}{32}$	○○○● ○ $\frac{0}{7}$

○ FRUIT SET ABSENT
● FRUIT SET PRESENT
COLOUR OF HYBRID FLOWERS

$$\frac{\text{NO. OF SEEDS GERMINATED}}{\text{NO. OF SEEDS SOWN}}$$

TABLE II

Hybridization in six strongly-scented H.T. roses

e y	Flower colour	Average pollen fertility %	Inter-varietal crosses						
			No. of crosses made	No. of fruit set	% of fruit set	No. of seeds sown	No. of seeds germinated	% of seed germination	No. of plants flowered
	Crimson	28	11	7	63·6	147	19	12·9	16
lerin*	Blackish crimson	26	19	12	63·6	141	5	3·5	4
ory	Deep crimson	36	13	4	30·7	119	14	11·7	10
wley	Dark crimson	32	14	10	71·4	127	22	17·3	15
burg	Apricot yellow reverse pink	19	23	2	8·7	5	0	..	..
	Rich crimson	36	19	10	52·6	139	15	10·8	13

npatible variety.

The number of seeds sown and germinated varied from variety to variety (Table I). The seeds sown in October showed better germination as compared with those sown in January. The percentage of seed germination varied from 12·9% to 10·8% in Aroma, Crimson Glory and Hadley. One to few seeds from all the inter-varietal crosses excepting Charles Mallerin × Aroma, Charles Mallerin × Gruss an Coburg, Charles Mallerin × Hadley, Crimson Glory × Gruss an Coburg and Hadley × Edward Mawley have germinated (Table I). The seedlings gave rise to first bloom in a period of 160 to 176 days after germination of the seed. Fifty-eight seedlings of five varieties produced flowers of pink and crimson colours as apparent from the tables. Mainly the plants which resulted from seeds sown in January died after producing a bloom, whereas, those sown in October survived. Some of the casualties occurred on account of high temperature prevailing during summer, in the first year of growth. Seven hybrid seedlings comprising of 15 plants and one selfed seedling are still growing well even after a period of nearly three years.

Fragrance was present in all hybrid flowers though there was a marked decline in its intensity in some of them, *e.g.*, in Aroma × Crimson Glory and Aroma × Edward Mawley. The pink flower colour of Gruss an Coburg dominated in crosses where this variety was used as the male parent (Table I). Two hybrid seedlings possessing intensely fragrant flowers are worth mentioning here, *i.e.*, Aroma × Gruss an Coburg and Edward Mawley × Gruss an Coburg. The bud shape was excellent in the former and the flowers of latter developed dark pink colour on the outer petal surface. In the crosses where crimson flowered parents have participated, the parental colour was maintained (Table I). Out of two hybrid seedlings of Charles Mallerin × Edward Mawley, one produced flowers of Edward Mawley colour and the other of Charles Mallerin colour the latter being darker in shade.

DISCUSSION

These six varieties are mainly self-incompatible though in some of the selfings, fruit set was obvious but the seeds either did not germinate or failed to establish themselves with the exception of a seedling in Charles Mallerin. The loss in vigour was apparent from the habit of this seedling which produced flowers with reduced size and petal number. This feature may be accounted for inbreeding depression which is usually apparent in some of the cross-pollinated plants. The existence of such depression has been emphasized in roses by Wylie (1954) and Eva (1968). In general, fruit set with higher number of seeds was recorded in inter-varietal crosses as compared to selfed. Similar reports have been made in certain crop plants also.

Stratification of rose seeds before sowing as recommended by Semeniuk and Stewart (1964), has been helpful in enhancing seed germination besides other environmental factors. The seeds which were sown in October showed better germination and survival which may be considered as a more suitable period for rose seed sowing under Lucknow climatical conditions. Low percentage of seed germination was due to delayed sowing of the second lot. Seeds which germinated were indistinguishable from the ones which did not as both appeared to be well developed before sowing.

Excepting for Charles Mallerin, in general the varieties which possessed higher amount of fertile pollen resulted in better fruit and seed set and subsequently seed germination. In the present experiment the inheritance of fragrance followed the same pattern as that reported by various rose breeders (Kordes, 1955; Gamble, 1957; and Klimenko, 1969). Since this character depends on the interaction of many genes, therefore, loss or gain in intensity of fragrance in hybrid flowers can easily be expected. A detailed chemical analysis of qualitative and quantitative characters of rose oil of parents and offsprings on per seedling basis will throw more light on nature and mode of inheritance of fragrance. The pink colour of Gruss an Coburg flowers have dominated over crimson colour of the other parent, as represented by three kinds of inter-varietal seedlings. Such dominance has been reported in roses by Wylie (1954), Klimenko (1969) and others.

ACKNOWLEDGEMENTS

Grateful thanks are due to Dr. L. B. Singh, Director, National Botanic Gardens, Lucknow, for facilities and encouragements, and to Dr. K. R. Khanna for guidance and keen interest in this work.

1. Eva, N., *The Rose Ann.*, 1968, p. 68.
2. Gamble, J. A., *Ibid.*, 1957, p. 22.
3. Klimenko, V., *Ibid.*, 1969, p. 122.
4. Kordes, W., *Ibid.*, 1955, p. 22.
5. Pal, B. P., *The Rose in India*, ICAR, New Delhi, 1966.
6. Semeniuk, P. and Stewart, R. N., *Proc. Amer. Soc. Hort. Sci.*, 1964, **85**, **639**.
7. Shahare, M. L. and Shastry, S. V. S., *Chromosoma* 1963, **13**, **702**.
8. Wylie, A. P., *Jour. Roy. Soc.*, 1954, **79**, 555.

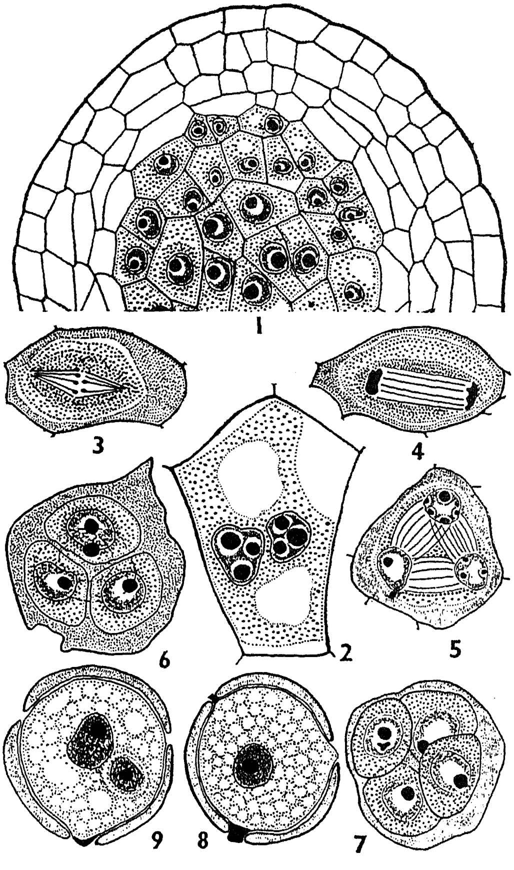
DEVELOPMENT OF MALE AND FEMALE GAMETOPHYTES IN *PRINSEPIA UTILIS* ROYLE

MANOJ KUMAR SHARMA AND H. S. NARAYANA
Department of Botany, University of Rajasthan, Jaipur

THE Rosaceae are remarkably well represented in India and are considerably important not only for their temperate fruits but also for their interesting cytological and embryological abnormalities. Rutishauser (1939), Wanscher (1939), Hakansson (1946), Christen (1950), Eaton (1951), Liljefors (1953), Hjelmquist (1956, 1957, 1959 *b*, 1962), and Sarfatti (1961) have studied the embryology of some members of this family. The present account on the development of male and female gametophytes of *Prinsepia utilis* which is collected from Ootacamund, South India, shows departure from that of the other members of the Rosaceae in certain details.

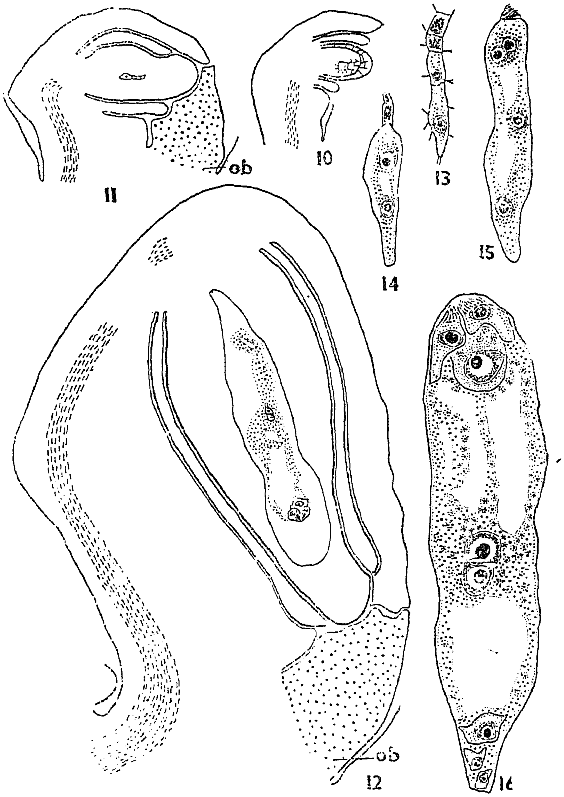
The microsporangial wall is four to five cells thick besides the epidermis (Fig. 1). The endothecium enlarges and becomes fibrous. The two to three middle layers get compressed as the anther matures. The tapetum is glandular and one to two cells thick. The tapetal cells are two- to three-nucleate and the nuclei are one- to many-nucleolate (Fig. 2). The microspore mother cells round off and undergo meiosis (Figs. 3-5). The cytokinesis is simultaneous resulting mostly in tetrahedral (Fig. 6), and rarely in decussate (Fig. 7) tetrads. The latter type is not reported earlier in the family. The microspores are liberated by the gelatinization of the mother cell-wall. The microspore is spherical with thick exine. The intine is thin all-round except at the region of one or two germ pores where it is thickened forming plugs (Fig. 8). The microspore divides to form a large vegetative cell and a small spherical generative cell with its own thin layer of cytoplasm (Fig. 9). Like other members of the family, the pollen grains are two-celled and tricolporate when shed.

In the ovular primordium the hypodermal archesporium divides transversely to form an outer primary parietal cell and an inner megaspore mother cell. The initials of the inner integument differentiate earlier than those of the outer. The nucellus elongates subsequently along with the growth in both the integuments and the enlargement of the megaspore mother cell, and curves at right angles to the funicle. A parietal tissue is formed by the division of both the primary parietal cell and the epidermal cells of the nucellus similar to other investigated members of the Rosaceae (Fig. 10). The inner integument is shorter than the outer which forms a collar around the nucellar tip (Fig. 12). Thus, a micropyle is not formed unlike other members of the family with the exception of North European *Alchemilla* (Hjelmquist, 1956). The megaspore mother cell



FIGS. 1-9. Fig. 1. Magnified view of the portion of microsporangium at microspore mother cell stage, × 983. Fig. 2. A 2-nucleate tapetal cell, × 2,800. Figs. 3-5. Divisional stages in the formation of tetrads, × 2,800. Figs. 6-7. Tetrahedral and decussate tetrads, × 2,800. Fig. 8. Uninucleate microspore, × 2,800 Fig. 9. 2-celled pollen grain, × 2,800.

divides meiotically to form a linear tetrad (Fig. 11). The lowermost megaspore functions while the upper three degenerate (Fig. 13). The degenerating remnants of the megaspores persist up to the four-nucleate stage of the embryo-sac (Figs. 14, 15). The functional megaspore enlarges and its nucleus divides mitotically thrice to organize a two-, four- and eight-nucleate embryo-sac (Figs. 14-16). The development of the female gametophyte is of the Polygonum type (Maheshwari, 1950). At the stage of mature embryo-sac, the nucellus curves completely bringing its tip close to the funicle and the ovule becomes anatropous (Fig. 12). The epidermal cells of the funicle proliferate and enlarge to form a massive obturator which is reported earlier only in Sorbus (Liljefors, 1953), and *Malus* and *Cotoneaster* (Hjelmquist, 1957, 1962). The egg apparatus consists of two pyriform or triangular synergids with terminal filiform apparatus which is not reported earlier in other members of the Rosaceae, and a sac-like egg. The antipodals are wedge-shaped diminishing basipetally in size. The lower polar nucleous migrates to the micropylar end, pairs with its counterpart (Fig. 16) and remains in this condition till fertilization unlike *Alchemilla* and *Malus* (Hjelmquist, 1956, 1957). The egg and the embryo-sac have plenty of starch grains as the reserve substance. The antipodals are ephemeral.



FIGS. 10-16 (*ob.* obturator). Figs. 10-12. Stages in the development of anatropous ovule, × 300. Fig 13. Linear tetrad, × 570. Fig. 14. 2-nucleate embryo-sac with degenerating remnants of megaspores, × 570. Fig 15. 4-nucleate embryo-sac with remnants of degenerating megaspores, × 570. Fig. 16. Organised embryo-sac, × 570.

We are grateful to Professor B. Tiagi for encouragement.

---

1. Christen, H. R., "Untersuchungen über die Embryologie pseudogamer und sexueller Rubusarten," *Ber. Schweiz., Bot. Ges.*, 1950, **60**, 153.
2. Eaton, G. W., "Apomixis in American polyploid blackberries," *Amer. J. Bot.*, 1951, **38**, 768.
3. Hakansson, A., "Untersuchungen über die Embryologie eniger *Potentilla*-Foremen," *Lunds. Univ. Arssk.*, 1946, **42**, 1.
4. Hjelmquist, H., "The embryology of some African *Alchemilla* species," *Bot. Notiser*, 1956, **109**, 21.
5. —, "The apomictic development in *Malus sieboldii*," *Ibid.*, 1957, **110**, 455.
6. —, "On the embryology of two *Malus* hybrids," *Ibid.*, 1959 *b*, **112**, 453.
7. —, "The embryo-sac development of some *Cotoneaster* species," *Ibid.*, 1962, **115**, 208.
8. Liljefors, A., "Studies on propagation, embryology, and pollination in *Sorbus*," *Acta Hort. Berg.*, 1953, **16**, 277.
9. Maheshwari, P., *An Introduction to the Embryology of Angiosperms*, New York, 1950
10. Rutishauser, A., "Zur Embryologie pseudogamer Potentillen," *Nat. Ges Schaffh.*, 1939, **15**, 203.
11. Sarfatti, G., "Accrescimento del pericarpo, seme endospermae embrion in *Prunus amygdalus*," *N. G. Bot. Ital.*, 1961, **68**, 118.
12. Wanscher, J. H., "Contribution to the cytology and life-history of apple and pear," *Roy. Vet. Agr. Col. Copenhagen Year Book*, 1939, p. 21.

LETTERS TO THE EDITOR

CALIBRATION OF SAMPLE TUBE DEAD SPACE IN ADSORPTION EXPERIMENTS WITHOUT USING HELIUM

In the determination of the surface area of solids by volumetric gas adsorption methods, one of the necessary steps is the calibration of the sample tube dead space (STD). The general practice is to use helium for this purpose. An alternative method, using nitrogen or any other gas in the place of helium, has been worked out by Loebenstein.[1] In this method, the geometric volume of the STD is determined at two different temperatures at which the gas is not adsorbed. The methods described in this paper are, in principle, similar to Loebenstein's method, but lead to a higher accuracy.

Figure 1 shows a part of a standard volumetric adsorption apparatus in which the volumes B and C form the sample tube dead space. A is the manometric dead space which is constant for the apparatus and can easily be determined by the expansion of a known amount of a gas. C is immersed in a constant temperature bath during an adsorption run and B is exposed to room temperature. The geometric volume of B and C can be determined by one of the following methods.

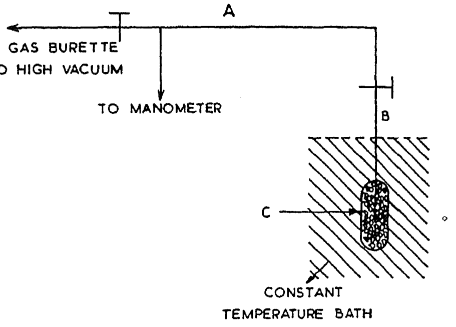


FIG. 1. Schematic of an adsorption apparatus.

(1) Let the absolute volumes of the dead spaces A, B and C be V_A, V_B and V_C respectively. Let the volumes of gas present in these dead spaces at standard temperature and pressure be $V_{A\,(NTP)}$, $V_{B\,(NTP)}$ and $V_{C\,(NTP)}$ respectively. A known quantity $(V_{(NTP)})$ of a gas, say nitrogen, is taken in the dead spaces A, B and C. C is immersed successively in baths maintained at different temperatures and the corresponding pressures are noted. Then,

$$\frac{P_0 . V_{(NTP)}}{T_0} = \frac{P\,(V_A + V_B)}{T_r} + \frac{P . V_C}{T} \qquad (1)$$

where P is the pressure in the system at the bath temperature T, T_r is the room temperature, P_0 and T_0 are the standard pressure and temperature. On rearranging Eqn. (1) we get,

$$\frac{1}{P} = \frac{(V_A + V_B)\,T_0}{V_{(NTP)}\,T_r P_0} + \frac{T_0 . V_C}{P_0 V_{(NTP)}} . \frac{1}{T} . \qquad (2)$$

$V_{(NTP)}$ being constant, a plot of 1/P against 1/T will be a straight line. From the slope and the intercept, V_C and $(V_A + V_B)$ are calculated.

This method requires that the room temperature T_r is constant. If there are fluctuations in T_r, the accuracy of the method will be affected in two ways: (*i*) the value of $(V_A + V_B)$ obtained from the intercept will be erroneous and (*ii*) the term corresponding to the intercept in Eqn. (2) will not be constant, thus affecting the linearity of the straight line.

(2) To minimise the errors arising out of fluctuations in T_r, a different approach may be adopted. Let V_{BC} be the volume of the STD, and the volume of the gas occupying the dead space be $V_{BC\,(NTP)}$. Now, at every bath temperature, $V_{BC\,(NTP)}$ can be calculated, since,

$$V_{BC\,(NTP)} = V_{(NTP)} - V_{A\,(NTP)}. \qquad (3)$$

By recording T_r, $V_{A(NTP)}$ and hence $V_{BC(NTP)}$ can be calculated accurately.

$$\frac{P_0 V_{BC\,(NTP)}}{T_0} = \frac{P \cdot V_B}{T_r} + \frac{P V_C}{T} . \qquad (4)$$

Hence,

$$\frac{V_{BC\,(NTP)}}{P} = \frac{V_B T_0}{T_r P_0} + \frac{V_C T_0}{P_0} . \frac{1}{T} . \qquad (5)$$

A plot of L.H.S. of Eqn. (5) against 1/T will be a straight line, whose intercept and slope will give the values of V_B and V_C respectively. V_B being small, any variation in the term $\frac{V_B T_0}{T_r P_0}$ of Eqn. (5) arising out of the fluctuations in T_r would be too small to affect the linearity of the plot.

Procedure 2 is applicable only to a constant volume adsorption system, but procedure 1 can be adapted for a system with an open limb manometer. For this purpose, the total pressure in the dead space is held constant at every temperature by suitably varying $V_{(NTP)}$. A plot of $V_{(NTP)}$ against 1/T will be a straight line. From the slope and intercept, V_C and $(V_A + V_B)$ are calculated.

V_B and V_C are the volumes of B and C. The quantity of gas occupying these dead spaces is calculated by converting V_B and V_C to NTP by employing the temperature and pressure at which the adsorption experiment is conducted. If the temperatures at which the adsorption and dead space determinations are carried out, are very much different from each other, a correction may be applied to account for the contraction of glass. This correction, however, is small and is, normally, about 0·1% for every 100° temperature difference.[1]

In order to check the reliability of the above methods, the dead space obtained from procedure 2 using nitrogen was compared with that obtained by the conventional method using helium at – 184° C. The temperatures used for the determination of the absolute dead space with nitrogen were 0°, 31·2°, 61·0°, 82·0° and 110° C. Liquid paraffin heated in a well-regulated electrical furnace was used as the bath material. The volume (NTP) of the gas present in the dead space obtained by the two methods are plotted as a function of pressure in Fig. 2. It is seen from the figure that the agreement between the present method and that using helium is excellent.

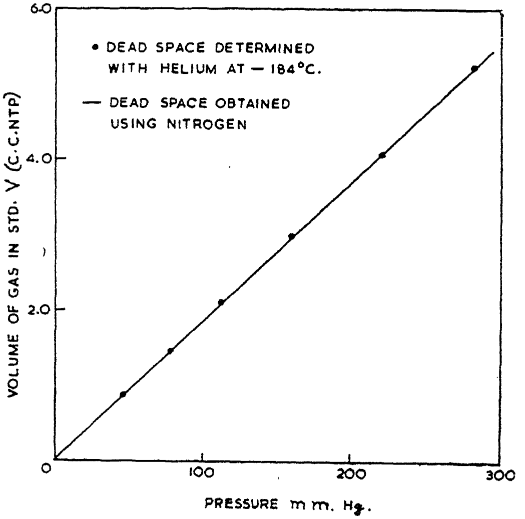


FIG. 2. A comparison of the calibration of sample tube dead space by the procedure 2 and by employing helium at – 184° C.

In the method described by Loebenstein,[1] theoretically, two experimental points are sufficient to calculate the absolute volumes of the dead spaces. However, to avoid experimental errors, an average of several determinations would be needed. In the present method, it is simpler to get a set of pressure readings by varying the bath temperature and the straight line graph gives the best average value of the dead space. A set of constant temperature baths can also be obtained by using salts having well-defined transition temperatures. It is important to employ only such temperatures at which the gas is not adsorbed. Nitrogen can be used in a temperature range of 0–100° C. even in the case of samples with large surface areas such as silica gel, metal oxides, etc. On metal surfaces, inert gases such as argon should be used.

The authors are thankful to Prof. M. R. A. Rao for helpful discussions. One of the authors (S. G. T. B.) is grateful to the CSIR for the award of a Junior Research Fellowship.

Dept. of Inorganic and Physical Chemistry,
Indian Institute of Science,
Bangalore-12, *August* 12, 1970.
S. G T. BHAT.
K. S. NARAYAN.

---

1. Loebenstein, W. V., *Jour. Chem. Phys.*, 1958, **29**, 236.

VARIABLE ORDERS IN THE BROMINATION OF *p*-NITROPHENOL

BROMINATION of aromatic substrates by molecular bromine in organic solvents often exhibits complex kinetics as evidenced by the variable orders in bromine. In acetic acid medium, the reaction is generally second order in bromine and first order in substrate at high concentrations of bromine. At low concentrations, the orders are one in each. For the overall third order process, the mechanism involves the electrophilic attack of a molecule of bromine on a 1 : 1 complex of bromine and the substrate in the rate-determining step.[1] In the second order process, the complex undergoes electrophilic attack by the molecules of solvent due to the low concentration of bromine. This kinetic interpretation has been found to be valid for substrates like anisole[2] and *p*-bromophenol.[3] It was considered interesting to see whether the same mechanism would still hold good for a comparatively less reactive substrate like *p*-nitrophenol where the susceptibility to electrophilic attack is less.

The kinetics of the bromination of *p*-nitrophenol was followed by determining the decrease in the concentration of bromine iodometrically as a function of time. In order to avoid the influence of products formed in the course of the reaction, the orders were determined from the initial rates.

The overall order of the bromination of *p*-nitrophenol was three for equimolar concentrations of the reactants over the concentration range 0·3 M to 0·018 M. The stoichiometry of the reaction was one. The order in *p*-nitrophenol determined by the isolation method[4] was one at all concentrations. At a constant *p*-nitrophenol concentration of 0·2 M, the order in bromine was two over a concentration range 0·018 M to 0·0085 M. With lower concentrations of bromine, the overall order became two and the order in bromine one. Curiously, the order in bromine decreased with an increase in the concentration of *p*-nitrophenol as well. For bromine concentrations ranging from 0·03 M to 0·005 M, the order decreased to 1·5 when the *p*-nitrophenol concentration was maintained between 0·3 M and 0·43 M. The order in bromine at still higher concentrations of *p*-nitrophenol could not be determined due to the limited solubility of the latter in acetic acid.

The variable orders observed with respect to bromine in the different concentration ranges suggests the possibility of parallel reactions. The rate of disappearance of bromine may be represented as

$$-\frac{d\,[\mathrm{Br}_2]}{dt} = k_2\,[p\text{-nitrophenol}]\,[\text{bromine}] + k_3\,[p\text{-nitrophenol}]\,[\text{bromine}]^2$$

either one of the processes or both becoming important depending on the concentrations. In the higher concentration region of bromine where an overall third order is observed, a molecule of bromine plays the part of the electrophile. At low concentrations, the free bromine concentration may be too small and the solvent molecule may itself act as the electrophile in the rate-determining step.[3] At higher concentration of *p*-nitrophenol, the formation of the 1 : 1 complex with bromine may so reduce the effective concentration of free bromine enabling the simultaneous occurrence of the second and third order processes. Under these conditions, on plotting rate/[(*p*-nitrophenol)] [(bromine)] against [bromine] a straight line with a positive intercept and slope was obtained confirming this suggestion. This could explain the overall 1·5 order in bromine observed at high concentrations of *p*-nitrophenol. However, this implies that the equilibrium constant for the formation of the 1 : 1 complex is still negligible compared to unity. This point is being investigated at present.

One of the authors (N. S.) is indebted to the CSIR for a Fellowship.

Dept. of Chemistry, N. SRIDHAR.
Indian Inst. of Technology, J. RAJARAM.
Madras-36, J. C. KURIACOSE.
July 24, 1970.

---

1. Norman, R. O. C. and Taylor, R., "Electrophilic *Substitution in Benzenoid Compounds* Elsvier, 1965, p. 128.
2. Gnanapragasam, N. S. and Yeddanapalli, L. M., *J. Indian Chem. Soc.*, 1959, **36**, 745.
3. Rajaram, J. and Kuriacose, J. C., *Aust. J. Chem.*, 1968, **21**, 3069.
4. Gnanapragasam, N. S. and Yeddanapalli, L. M., *J. Chem. Soc.*, 1956, p. 4934.

CHEMICAL INVESTIGATION OF *BISCHOFIA JAVANICA*

Bischofia javanica (Euphorbiaceae) Blume is a large ever-green tree found in sub-Himalayan forests, in Orissa, and on the west coast from Konkan to Nilgiris.[1] The juice of its leaves is a cure for sores.[1]

During the chemical investigation of the root of *B. javanica*, β-amyrin, ursolic acid, and β-sitosterol have been identified in the non-saponifiable part.

The coarsely-powdered air-dried root (2 kg.) of *B. javanica* was exhaustively extracted with ethanol, filtered and the solvent was removed. The residue was soxhlated with petroleum ether (60–80°) and the petroleum ether evaporated to dryness. The material was hydrolysed with 15% methanolic potassium hydroxide solution and the non-saponifiable fraction, obtained in the usual manner was subjected to column chromatographic separation over alumina, from which three compounds could be isolated and identified.

The compound A (450 mg.) eluted with petroleum ether-benzene (1 : 2), was crystallised from a mixture of chloroform-methanol in the form of needles, m.p. 195–96°, $(\alpha)_D + 84°$ ($CHCl_3$) [Lit.[2] m.p. of β-amyrin, 199–200° $(\alpha)_D + 89°$]. With acetic anhydride and pyridine, it formed an acetate which on chromatography over alumina, melted at 239–40°, $(\alpha)_D +$ 82° ($CHCl_3$). It was identified as β-amyrin by mixed m.p. of its acetate with an authentic specimen of β-amyrin acetate.

The compound B (430 mg.) could not be crystallised. It gave all tests of triterpenoids and formed a monoethyl ester with ethereal solution of diazomethane, m.p. 168°, $(\alpha)_D + 57°$. (Found: C, 78·92; H, 10·87 calc. for $C_{31}H_{50}O_3$. C, 79·15; H, 10·64%). Further, it was hydrolysed by refluxing with 20% alcoholic caustic potash for 6 hours on a steam-bath, cooled, diluted and acidified with dil. HCl, when a white mass was precipitated. It was extracted with ether, washed with water, dried and the ether evaporated to dryness. The residue was repeatedly crystallised from ethyl alcohol as needles, m.p. 284–86°, $(\alpha)_D + 62°$ ($CHCl_3$), $\nu_{max.}$ 3,525 cm.$^{-1}$ (hydroxyl) 1,716 cm.$^{-1}$ (acid C = O), and 1,482 cm.$^{-1}$ ($C-CH_3$). These properties indicated the substance to be ursolic acid and the identity was confirmed by comparison with an authentic sample.

The compound C (310 mg.) crystallised from chloroform-acetone as colourless plates melted at 136°. It gave blue coloration with Libermann-Burchard reagent and yellow with tetranitromethane. It formed an acetate, m.p. 126–27°, $(\alpha)_D - 39°$ ($CHCl_3$), benzoate, m.p. 145° and was found identical with β-sitosterol, which was confirmed by its m.p. and mixed m.p. with an authentic sample of β-sitosterol and co-TLC.

Thanks are due to Dr. S. C. Kushwaha of Wisconsin University (U.S.A.) for IR spectrum and samples of β-amyrin acetate and ursolic acid.

Dept. of Chemistry, S. S. MISRA.
H.B. Technological Inst., R. S. TEWARI.
Kanpur, *August* 26, 1970.

---

1. Chopra Nayar and Chopra, *Glossary of Indian Medicinal Plants*, CSIR. India, p. 37.
2. Simpson and Ross, *The Terpenes*, The University Press, Cambridge, 1956, **4**, 175.

A PRELIMINARY REPORT ON THE TOXIC NATURE OF *ASPERGILLUS CANDIDUS*, A COMMON FOOD CONTAMINANT*

MANY fungi are known to produce metabolites that are toxic to animals.[1] In a few cases, the metabolites have been well characterised.[2] The study of the toxins produced by fungi which are common food contaminants is becoming increasingly important. In our laboratory we are interested in the study of some toxic fungi belonging to the *Aspergillus* and *Penicillium* species, which are reported to be common food contaminants.[3] The present report is on the toxic nature of *Aspergillus candidus* studied on chicks and mice.

The organism was grown at room temperature in Richard's medium in a Haffkin's flask for 25 to 30 days. The mycelia were harvested and the culture filtrate was passed through cotton and then through a Seitz filter. The filtrate was concentrated to about a twentieth of the original volume under vacuo. Suitable aliquots were used in the feeding experiments.

About 50 ml. of the concentrated culture filtrate was extracted with double volume of chloroform for half-an-hour in a reciprocating shaker. The operation was repeated thrice, each time with fresh solvent. The extracts were pooled and concentrated to dryness to remove the chloroform and the residue was suspended in hot distilled water. This extract as well as the aqueous layer after chloroform extraction were fed to the animals.

To each of the 20 numbers of a-day-old white leghorn single-combed chicks was given 0·5 ml. of the concentrated culture filtrate orally and to the controls 0·5 ml. of water was administered. A 100% mortality was observed after second feeding of the culture filtrate. The chloroform extract (0·25 ml. corresponds to 0·5 ml. of concentrated culture filtrate) was also found to be equally lethal to chicks.

Groups of 12 mice were fed with commercial diet mixed with the concentrated culture filtrate (1 ml./mouse); or the chloroform extract (equivalent to 1 ml. concentrated culture filtrate); or the aqueous layer left over after the chloroform extraction (1 ml./mouse). All the mice fed with culture filtrate or the chloroform extract died after the fourth feeding whereas the controls and the aqueous layer left after chloroform extraction fed groups survived and looked normal.

Since, under the growth conditions used in the present investigation, the nephrotoxin "citrinin" is produced,[4] it was of interest to see whether any other toxic principles, other than citrinin were also present. Studies along this line after decitrinising[5] shows that there is in fact highly potent toxic principle(s) present. The production of this potent toxin(s) seems to vary much from batch to batch.

Univ. Biochem. C. S. RAMADOSS.
Res. Labs., E. R. B. SHANMUGASUNDARAM.
Madras-25, *September* 30, 1970.

---

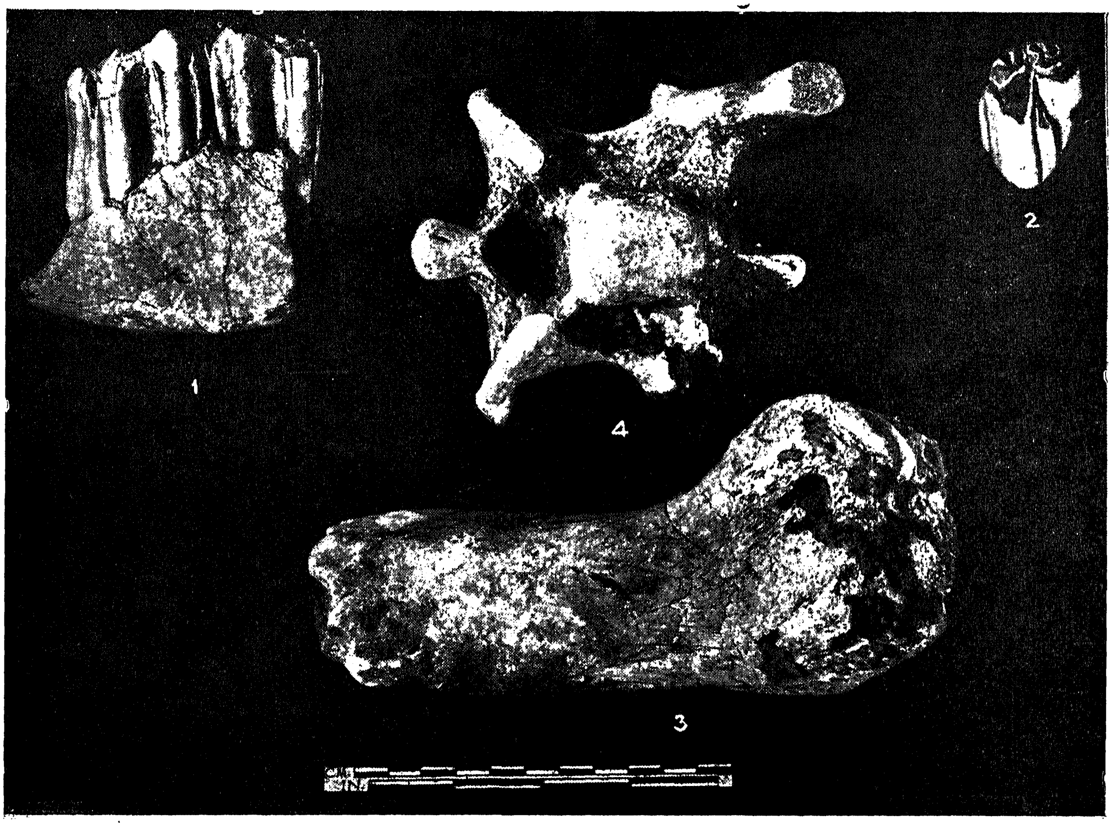
* This research has been financed in part by a grant made by the United States Department of Agriculture under PL. 480.

1. Brook, P. J. and White, E. P., *Ann. Rev. Phytopath.*, 1966, **4**, 171.
2. Hesseltine, C. W., *Mycopathol. Mycol. Appl.*, 1969, **39**, **371**.
3. Richard, J. L., Tiffany, L. H. and Pier, A. C., *Ibid.*, 1969, **38**, 313.
4. Spector, W. S., *Handbook of Toxicology*, *Vol. II: Antibiotics*, W. B. Saunders Co., Philadelphia and London, 1957, pp. 138.
5. Glover, I. T. and Limbaugh, C. L., *J. Chem. Educ.*, 1969, **46**, **866**.

FOSSILS AND MIDDLE STONE AGE TOOLS FROM NANDUR-MADHMESHWAR ON THE GODAVARI RIVER (NASIK DISTRICT, MAHARASHTRA STATE)

GANGAPUR and Nandur-Madhmeshwar are the two important localities in the upper reaches of the Godavari river, which have yielded pleistocene fossils and Stone Age tools. In the excavations at the first site in 1966, a fragmentary mandible of *Bos* was found by the writers in association with the Early Stone Age implements.[1] At the second site situated at the confluence of the Godavari and the Kadva, the fossils have been obtained from the river bed while the Middle Stone Age and Late Stone Age tools were recovered from the exposed cliff sections on the left bank down stream from the dam. Both these localities were examined in February 1970, to estimate the erosion of the tool- and fossil-bearing sections caused by the excessive floods of the year 1969–70. The cliff near Gangapur was very little affected by the floods. The small new cuts yielded a good number of Early Stone Age artefacts but no fossils.

At Nandur-Madhmeshwar, the flood effect was rather extensive. Some earlier sections had completely disappeared while fresh ones had been exposed, particularly towards the village. The section, which had yielded Late Stone Age artefacts in 1966 from the river bed upward, was composed of 3 m. yellowish-brown silt, overlaid by 1·5 m. sandy fine gravel containing Late Stone Age tools and then 1 m. yellow silt and on the top was 0·5 m. dark brown surface soil. This section had been



FIGS. 1–4

washed off by the floods. The freshly exposed section from the bottom upwards consisted of about one metre dark fine sandy gravel overlaid by a thick light brown or yellowish-brown silt and at the top capped by reddish-brown soil. Towards the village and adjacent to a gulley was a massive deposit of silt showing alternate blackish and brownish layers replacing a part of the deposits exposed in the section. Evidently, it is a later deposit. The washed-off section, therefore, appears to have rested against the reddish-brown silt now seen exposed in the recent section.

The basal sandy gravel in the present section yielded fossils and Middle Age tools all *in situ* and well preserved. The fossils[2] are of *Bos* species and this appears to be the first time *Bos* has been found in association with the Middle Stone Age artefacts at Nandur-Madhmeshwar. The four pieces of fossils are (1) lower jaw fragment, (2) upper molar tooth, (3) distal fragment of humerus, and (4) an incomplete vertebra. All the specimens indicate signs of semi-mineralization. At this stage it is not possible to differentiate between the *Bos* species found previously at Gangapur with the Early Stone Age tools and the present fossils obtained in association with the Middle Stone Age implements. The section at Nandur-Madhmeshwar, however, appears to be of Upper Pleistocene horizon.

The Middle Stone Age tools are made of chert and chalcedony and comprise of scrapers, point and worked flakes.

Archaeological Survey of India, R. V. Joshi.
Prehistory Branch, S. A. Sali.
Nagpur, *September* 19, 1970.

---

1. Joshi. R. V. *et al.*, "Animal fossil and Early Stone Age tools from Gangapur on the Godavari river (Nasik Dist., Maharashtra State)," *Curr. Sci.*, 1966, **35** (13), 344.
2. The fossils were kindly studied by Sri. V. V. Rao, Excavations Branch, Archaeological Survey of India, Nagpur.

LEACHING PATTERNS OF MONAZITE AND ZIRCON

Studies on the leaching patterns of the radioactive minerals—monazite and zircon are important from the point of view of geochemistry, radiometric dating and hydrometallurgical extraction of uranium. Such studies bearing on the leaching of uranium have been carried out by Hurley (1950), Brown *et al.* (1953 *a, b*) and Shankar and Krishna (1957). Larsen, Jr., Phair, Gottfried and Smith (1956) studied the leaching pattern of uranium in granite and also in rock-forming minerals separated from granite. Picciotto (quoted by Rankama, p. 108, 1956) showed that 58% of the total activity of the rock was contained in strongly radioactive inclusions while the major constituents contain only 28%. In view of this, an attempt has been made to study the leaching pattern of monazite and zircon which commonly contribute, in large proportion, to the total activity of granite.

Literature in nuclear geology reveals that large amounts of uranium can be lost during oxidation by solution in meteoric circulation, particularly in acid waters. This contrasts with the behaviour of thorium and zirconium. The primary compounds of these elements are chemically stable and quite insoluble. Hence, monazite and zircon are selected in the present study—the former being uranium-bearing, while the latter is a prime receptor of uranium which is accommodated structurally during magmatic crystallisation.

In this study, these two minerals occurring in the black sand concentrates, and passing through 60-mesh sieve were used. They were separated and purified with the aid of Frantz Isodynamic Laboratory Model L_1 magnetic separator, and samples of 99·8% purity were obtained. Their β-activity was determined with a Geiger-Muller counting system (supplied by Atomic Energy Establishment, Trombay) consisting of utility-scaler (Type DS 4110), preset timer (ET 450) and Geiger-Muller tube (I 1030) which is of end-window type with a wall thickness of 3 mg./cm.^{2} and operating voltage of 1375 V. The β-activity values obtained for monazite and zircon are 4074 and 72 counts per minute (CPM) respectively.

Each sample, weighing 10 gm. was autoclaved with 50 ml. of 1 N, 2 N, 3 N, 4 N, and 5 N of acetic, hydrochloric, nitric and sulphuric acids for two hours at a pressure of 1 kg./cm.^{2} Then the β-activity of each sample was determined (Table I).

The differences in the β-activity values of each mineral sample prior to, and after, acid treatment account for the loss of uranium by leaching.

The amount of leached uranium does not seem to have any bearing on the strength of the acid as revealed from Table I.

Much of the rare earth constituents are also readily leachable along with uranium (Brown *et al.*, 1953 *a, b*). Hence, the differences in the observed values in monazite, under study, may

TABLE I

Sl. No.	Acid	Normality	β⁻-activity in CPM	
			Zircon	Monazite
1	Acetic acid	1N	61	3816
		2N	54	3818
		3N	60	3620
		4N	48	3762
		5N	48	3674
2	Hydrochloric acid	1N	50	3858
		2N	58	3732
		3N	60	3960
		4N	50	3954
		5N	46	3842
3	Nitric acid	1N	48	3836
		2N	44	3894
		3N	44	3906
		4N	50	3758
		5N	46	3698
4	Sulphuric acid	1N	58	3760
		2N	50	3928
		3N	48	3838
		4N	60	3884
		5N	60	3788

not wholly represent the loss of leached uranium.

Dept. of Geology, E. A. V. PRASAD.
Sri Venkateswara Univ., M. G. C. NAIDU.
Tirupati (A.P.), *September* 23, 1970.

---

1. Brown, H. *et al.*, *Geol. Soc. Amer. Bull.* (Abstract), 1953 *a*, **64**, 1400.
2. —, *Ibid.*, 1953 *b*, **64**, 1400.
3. Hurley, P. M., *Ibid.*, 1950, **61**, 1.
4. Larsen, Jr., Phair, G., Gottfried, D. and Smith, W. S., *Proceedings of the International Conference on the Peaceful Uses of Atomic Energy* (*Geology of Uranium and Thorium*), United Nations, New York, 1956, **6**, 240.
5. Rankama, K., *Isotope Geology*, Pergamon Press, Ltd., London, 1956, p. 477.
6. Shankar, J. and Krishna, B. H., *Symposium on "Rare Metals"*, Atomic Energy Establishment and the Indian Institute of Metals, Bombay, 1957, p. 40.

SEX DIMORPHISM IN THE BOMBARDIER BEETLE *PHEROPSOPHUS HILARIS*, FABR., (CARABIDAE : COLEOPTERA)

Pheropsophus hilaris, Fabr., is a predacious, medium-sized (about 15 mm. in length) carabid beetle occurring in moist soil. The beetle is active in the night time and is found throughout South India. Since it feeds on many insect pests of agricultural crops, it is regarded as an economically useful insect (Andrews, 1929).[1] Owing to the usefulness of the insect, an attempt was made to identify the sexes from external appearance of the beetle in the field and thereby to determine the proportion of males and females in the population.

Males and females are generally alike among Coleoptera. Sexual dimorphism has been indicated among beetles by Andrews,[1] Ayyappa,[2] and Imms[3] in structures like mandibles, stridulating organs, antennae and protarsi.

The present note deals with the description of certain easily visible morphological features by which sexes in *P. hilaris* can be identified in the field. The eighth abdominal tergite in the female bears a row of spines on its posterior margin (Fig. 1-B). The spines being closely arranged give a pectinate appearance. Such spines are conspicuous by their absence in the corresponding tergite in the male wherein the posterior margin of the eighth abdominal tergite is plain (Fig. 1-A).

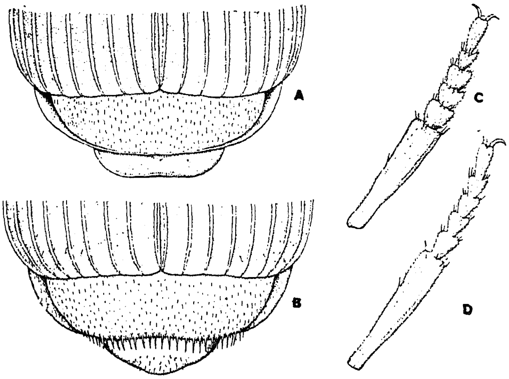


FIG. 1 A-D. *Pheropsophus hilaris.* A—Posterior abdomen of male; B—Posterior abdomen of female; C—Protarsus of male; D—Protarsus of female. (Camera lucida drawing).

Sexes in *P. hilaris* can be recognised by features of protarsi also. In the male, the proximal three protarsal segments are dilated and appear relatively larger than the distal two segments (Fig. 1-C). In the female, all the protarsal segments are comparatively of uniform size (Fig. 1-D). Average diameter measurements of protarsal segments, taken with the aid of micrometer are shown in Table I.

TABLE I

Average diameter measurements (mm.) of protarsal segments in P. hilaris

No. of protarsal segments from proximal to distal end	Male	Female
1	0·408	0·30
2	0·402	0·30
3	0·363	0·29
4	0·291	0·27
5	0·231	0·24

The dimorphic traits involving eighth abdominal segment and protarsi can be made out even by the naked eye; with a hand lens they can be seen distinctly. The relationship between the traits described, and the sexes was proved by dissection and examination of 100 specimens from random sample.

Our thanks are due to the authorities of Pachiayappa's College, Madras, for facilities and encouragement.

Dept. of Zoology, N. P. KALYANAM.
Pachaiyappa's College, K. SHANMUGHAM.
Madras-30, India, *October* 1, 1970.

---

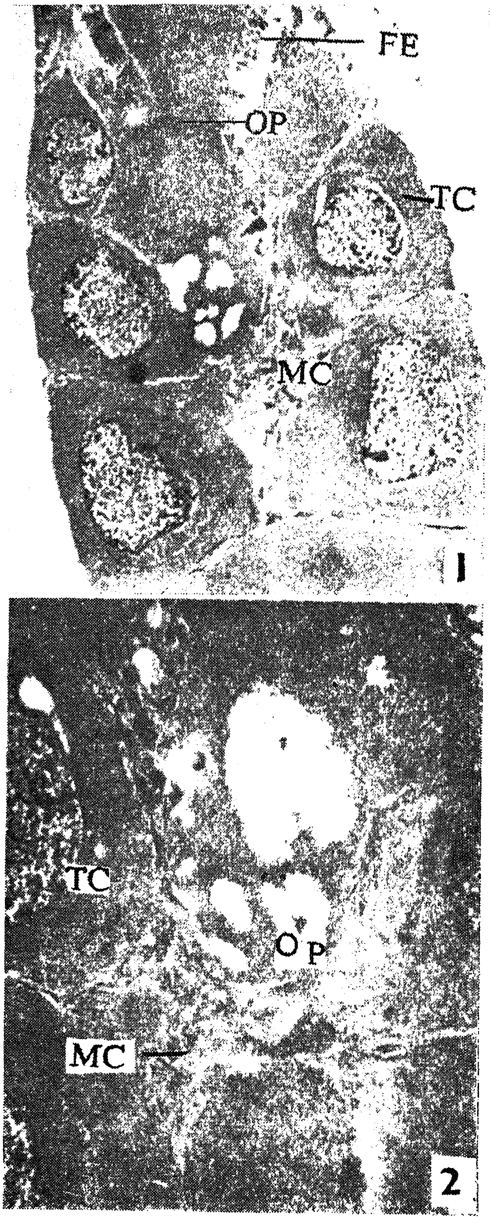
1. Andrews, H. E., *Fauna of British India* (Coleoptera: Carabidae), 1929, **1**, 31.
2. Ayyappa, P. K. *et al.*, *Ind. J. Ent.*, 1964, **26**, 279.
3. Imms, A. D., *A General Text-Book of Entomology*, Methuen & Co., Ltd., 1957.

SOME OBSERVATIONS ON THE FOLLICULAR EPITHELIUM OF *CYBISTER* (COLEOPTERA)

THE direct passage of nutritive substances from the trophocytes and the follicular epithelial cells has been described by Bonhag (1955), Schrader and Leuchtenberger (1952) and Saini (1967). According to Raven (1961), the auxillary cells have an important role in the nutrition of the oocytes.

Bonhag (1955) has mentioned that RNA and other nutritive substances are passed from the trophocyte to the oocyte in the telotrophic ovary of *Oncopeltus*. Similarly, DNA and other substances are passed from the trophocyte to the oocyte, where many nuclei join to form a lump of nuclear matter. Some nuclei from the apical and peripheral region pass into the trophic core where some giant nuclei are disintegrated and taken up by the trophic core (Schrader and Leuchtenberger, 1952; Bonhag, 1955).

Here in *Cybister* which has a polytrophic ovary, the nutritive substances are also passed from the trophocytes which would be described elsewhere, but an interesting feature is the behaviour of the follicular epithelial cells. The follicular epithelial cells at the beginning of the vitellarium increase by mitosis and their nuclei are passed in clusters, close to the trophocyte cytoplasm, where these nuclei are seen collapsing. Here these are taken up by the developing oocyte processes (Figs. 1 and 2). In this way in *Cybister* the follicular epithelial cells form a raw material of RNA and DNA which is taken up by the oocyte. This type of behaviour of follicular epithelium is rather new to be described. Although Sani (1967) has marked that RNA from the follicular epithelium is passed into the nutritive cord of *Aulacophora*. As regards the structure of *Dytiscus* ovary, it has been described by Nussbaum



FIGS. 1–2. Fig. 1. L.S. through ovariole of *Cybister* showing the follicular epithelium and oocyte process. Fig. 2. L.S. through ovariole of *Cybister* showing the migrating epithelial cells.

FE, Follicular epithelium; MC, Migrating epithelial cells; OP, Oocyte process; TC, Trophocytes.

(1917) but such a role of follicular epithelium has not been described so far.

A detailed account dealing with the histochemistry would be mentioned elsewhere.

I wish to express my gratitude to Dr. R. S. Saini, for his guidance and criticism.

Dept. of Zoology, P. K. SHRIVASTAVA.
University of Saugar,
Sagar (M.P.), *September* 29, 1970.

---

1. Bonhag, P. F., "Histochemical studies of the ovarian nurse tissues and oocytes of the milkwood bug, *Oncopeltus fasciatus* (Dallas). I. Cytology, nucleic acids, and carbohydrates," *J. Morphol.*, 1955, **96, 381.**
2. Nussbaum-Hilarowicz, J., "Uber das Verhalten des chondrioms während der Eibildung bei Dytiscus marginalis—L.," *Z. Wiss. Zool.*, 1917. p. 117.
3. Raven, Chr, P., *Cognesis: The storage of Development Information*, Pergamon Press, New York, 1961, p. 1.
4. Saini, R. S., "Histochemical and cytological studies on the ovarian development of *Aulacophora foveicollis Luc.* (Chrysomelidae: Coleoptera), *Indian J. Ent.*, 1967, **29** (4), 353.
5. Schräder, F. and Leuchtenberger, C, "The origin of certain nutritive substances in the eggs of Hemiptera," *Exptl. Cell. Res.*, 1952, **3,** 136.

OCCURRENCE OF *ARENICOLA BRASILIENSIS* NONATO IN RATNAGIRI

ON the 3rd April, 1969, several egg cases, gelainous in nature, were encountered, during a shore collection at Mirkarwada, Ratnagiri, in a sandy habitat, with a distinct narrow stalk running down into the head shaft of the burow. These were brought to the laboratory and kept in a glass trough, 16 cm. diameter, with ea-water. On the next day, swarms of polyhaete-larvae were observed in the glass trough. Search for polychaets in the same locality at he shore revealed only the worm-castings near he egg-masses. Taking a lead of these castngs, digging up to 25 cm. below the surface howed the presence of U-shaped burrows, from which several specimens of *Arenicola*, varying n size from 100 to 140 mm. were collected. hese were kindly identified, as *A. brasiliensis* y Dr. G. P. Wells.

A. brasiliensis Nonato is a widely distributed pecies in tropical and sub-tropical region. lthough Nonato[1] first described *A. brasiliensis* s a new species, specimens of this species ere collected by Professor Ashworth, from Woods Hole region (*vide* Wells,[2] pp. 2). Tampi nd Rangarajan[4] have recorded *A. brasiliensis* om Andaman and Nicobar Islands.

A. brasiliensis has so far been reported from Oods Hole (Wells[3]), Hawaii (coll. Edmondson), California (Ashworth[5]), Peru (coll. Koepcke), China (coll. Tchang), Western Australia (Jarman), Japan (Ashworth[5]) and Suez (Ashworth[5]). This is the first record of *A. brasiliensis* Nonato from the west coast of India, thus extending its geographical distribution.

I am greatly thankful to Dr. G. P. Wells for identification of the species, and to Dr. C. V. Kulkarni and Dr. H G. Kewalramani for their encouragement. My thanks are also due to Dr. M. R. Ranade, for helpful suggestions.

Marine Biol. Res. Station, U. D. GAIKWAD.
Ratnagiri, *July* 27, 1970.

---

1. Nonato, E., *Contr. Avulsa Inst. Oceanogr.*, 1958, **3, 1.**
2. Wells. G. P., *Proc. Zool. Soc. Lond.*, 1961, **137,** Part I, 1.
3. —, *Ibid.*, 1962 **138,** Part III, 331.
4. Tampi. P. R. S. and Rangarajan, K., *J. Mar. Biol. India*, 1963, 5 (1), 1.
5. Ashworth, J. H., *Proc. U.S. nat. Mus.*, 1911 *a*, **39, 1.**

ON THE OPTIMAL SAMPLING TIME FOR ASSESSMENT OF NEMATODE POPULATIONS IN RICE SOILS

THE root nematode (*Hirschmanniella* sp.) and stunt nematodes (*Tylenchorhynchus* sp.) are common in most rice soils and their populations are reported to fluctuate during the different seasons (Rao, 1969). In estimating the soil population of parasitic nematodes, it is essential to determine the optimal time of sampling for an appraisal of the density of the nematode in relation to the growth of the plants. With the above object in view, during 1969–70, soils with growing crop of variety IR-8 were sampled at the rate of one aliquot sample per 25 sq. m. area according to the method described earlier (Israel *et al.*, 1968) at intervals of a fortnight commencing from the date of transplanting rice till the harvest of the crop, on the farm at the Central Rice Research Institute, Cuttack.

Analysis of samples showed that *Hirschmanniella mucronata* Das (1960) Luc and Goodey (1963), *Tylenchorhynchus claytoni* Steiner (1937), *T. elegans* Siddiqi (1961) and *T. martini* Fielding (1956) prevailed in the above descending order of population, besides a considerable population of *Tylenchus* sp., *Hoplolaimus* sp., *Helicotylenchus* sp., *Hemicriconemoides* sp. and *Dorylaimids*.

The soil population of *H. mucronata* increased by 1·6, 4·0, 8·2 and 9·5 times the original population at planting during the successive fortnights and declined to 2·5 and 1·5 times the original population when the crop was ready for harvest. On the other hand, the population of *Tylenchorhynchus* sp. steadily increased by 1·6, 2·9, 3·5, 4·1 and 5·2 times the original population at planting and reduced to 2·5 times the original population at harvest (Fig. 1). Tillering in the rice plants stopped after the crop reached flowering stage as in other rice varieties. Yamakawa and Kishikawa (1957) reported that the root increase was found to be earlier by 15 days than the increase in tillering in rice plant. The initial population of the nematode was 64 *Hirschmanniella* sp. and 15 *Tylenchorhynchus* sp. per 100 gm. soil. The population of the nematodes increased from low numbers till the root production increased, after which there was a decline.

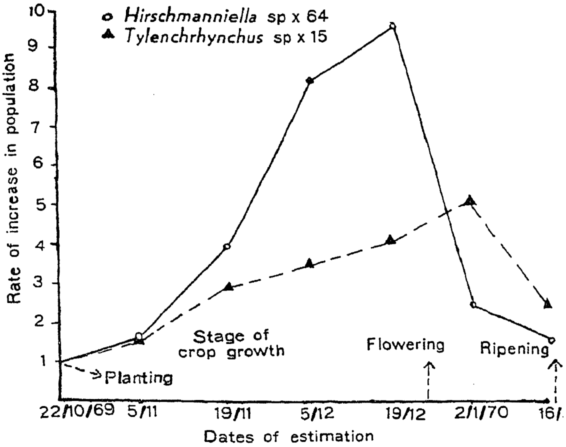


FIG. 1. Fluctuation of parasitic nematode population in soils with standing crop of rice var. IR-8 (Population in 100 gm. soil-mean of 16 samples).

It was evident from the data that the peak populations of the parasitic nematodes prevailed at flowering time of the variety and the optimal time for sampling soils was at or prior to flowering of the rice crop.

Central Rice Res. Institute, P. K. DAS.
Cuttack-6, *September* 9, 1970. Y. S. RAO.

---

1. Israel, P. Rao, Y. S. and Rao, Y. R. V. J., "Studies on nematodes of rice and rice soils," *Oryza*, 1968 (In press).
2. Rao, Y. S., "Nematodes affecting rice production," *PANS Manual on Rice*, 1969.
3. Yamakawa, Y. and Kishikawa, H., "Studies on cultivating periods of rice plant in warmer districts of Japan. III. Effect of change of cultivation on the root development of rice plant, the temperature and oxidation reduction potentials in paddy fields," *Agri. Bull. Saga. Univ.*, 1957, 5, 41.

EFFECT OF DOLICHOS YELLOW MOSAIC ON CHLOROPHYLL AND LEAF PROTEINS

CHLOROPHYLL content is known to be reduced in leaves infected with mosaic type of viruses. It has been suggested that the lower chlorophyll content may be due to the stimulation of chlorophyll destroying enzyme or may be due to the utilisation of plastid protein for the synthesis of virus protein.[1] The present investigation was carried out to examine whether such phenomenon exists in *Dolichos lab-lab* L. leaves infected by yellow mosaic virus.

Healthy and diseased *D. lab-lab* leaves of same age were collected from Co. 4 variety and used for the analysis of chlorophyll, chlorophyllase, chloroplastic protein and cytoplasmic protein. The chlorophyll was extracted in acetone and estimated spectrophotometrically[2]. The residue remaining after the extraction of chlorophyll was used to assess the chlorophyllase activity. The altered chlorophyll in the reaction mixture was extracted with 0·02 N potassium hydroxide containing a few drops of methanol.[3] The chloroplastic protein and cytoplasmic protein in leaf extracts were separated by centrifugation. The chloroplastic protein was precipitated with 0·2 M calcium chloride and cytoplasmic protein was precipitated by adjusting the pH of solution remaining after the separation of chloroplastic protein to 4·4.[4]

TABLE I

Chlorophyll content, chlorophyllase activity and content of leaf proteins in healthy and mosaic affected D. lab-lab *leaves*

(Chlorophyllase activity expressed as colorimeter readings, taking healthy as 100)

Nature of leaf	Chlorophyll *a* (mg/g)	Chlorophyll *b* (mg/g)	Chlorophyllase activity	Chloroplastic protein (mg/g)	Cytoplasmic protein (mg/g)
Healthy ..	0·650	0·264	100	21·88	3·18
Diseased ..	0·420	0·142	118	11·52	3·54

The results (Table I) indicate that there was a reduction in the levels of chlorophyll *a* and chlorophyll *b* in diseased leaves while the activity of chlorophyllase was stimulated in diseased leaves. Decreased amounts of chlorophyll *a* by 35·4% and chlorophyll *b* 46·2% were observed in diseased leaves over the healthy leaves whereas the chlorophyllase activity was increased by 18% in diseased leaves. The increased chlorophyllase activity in diseased leaves may destroy the chlorophyll. The level of chloroplastic protein was decreased in diseased leaves with a *pari passu* increase in cytoplasmic protein. Chloroplastic protein content of diseased leaves was 52·7% of the healthy leaves while the cytoplasmic protein content was higher by 10·2%. The chloroplasts are known to contain 50% protein.[5] Boardman and Zaitlin[6] reported that TMV protein was synthesised inside the chloroplasts. These reports coupled with the present findings lend support to the view that chloroplastic protein is utilised for the virus protein synthesis resulting in a depletion of chlorophyll level. The increased level of cytoplasmic protein in diseased leaves may be due to the presence of the virus in the cytoplasm.

The authors are indebted to Prof. K. Ramakrishnan, Dean, Agricultural College and Research Institute, Coimbatore, for the critical reading of the manuscript.

Division of Plant G. CHINNADURAI.*
Pathology, M. CHANDRASEKHRAN NAIR.
Agricultural College and
Research Institute,
Coimbatore-3, *August* 14, 1970.

---

* Present address: Laboratorie de Phytopathologie, 3030, Hervellee, Belgium.

1. Bawden F. C., *Plant Viruses and Virus Diseases*, Chronica Botanica Company, Waltham, Mass., U.S.A., 1956, p. 335.
2. Smith, J. H. C. and Benitz, A., *Modern Methods of Plant Analysis*—4, Springer-Verlag, Berlin, 1955, p. 142.
3. Willstätter, R. and Stroll, A., *Investigations on Chlorophyll*, Translated by F. M. Schertz and A. R. Merz, Science Press, Lancastor, pa, 1928.
4. Yemm, E. W. and Folkes, B. F., *Biochem. J.*, 1953, **55**, 700.
5. Rabinowitch N. I., *Photosynthesis I*, Interscience Publishers, Inc., New York. 1945, p. 599.
6. Broadman, N. K. and Zaitlin, M., *Virology*, 1958, **6**, 758.

EFFECT OF PRE-TREATMENT OF LEAVES OF *COLEUS BLUMEI*, BENTH. WITH CYTOKININS ON AMINO-ACID INDUCED ABSCISSION OF DEBLADED PETIOLES

PRE-TREATMENT of leaves of *Coleus blumei*, Benth. with benzyl adenine (BA) enhances the delaying effect of indoleacetic acid (IAA), on the abscission of debladed petioles of such leaves.[1] It was suggested that this (BA-enhancement of delaying effect of IAA) is due to protein synthesis at the abscission zone, promoted by cytokinin treatment, as protein synthesis has been shown to be essential for auxin action.[2,3] It is also shown that when inhibitors of protein synthesis are applied to debladed petioles, abscission is promoted.[4] Naturally-occurring amino-acids are reported to accelerate abscission of the unfertilized ovaries in tobacco.[5] Further, when C^{14} labelled—methionine and DL-phenylalanine 3-C^{14} are applied, there is accumulation in the abscission zone.[6]

Experiments were conducted to see if prior treatment of leaves with cytokinins would promote protein synthesis, involving greater utilization of externally applied amino-acids, thus mitigating the promotive effect of these amino-acids on abscission.

Coleus plants (propagated from a single clone), 1½-2 months old, were used in these experiments. Ten leaves each were treated with distilled water, benzyl adenine at 20 ppm and kinetin at 20 ppm every day for 9 days by smearing with a cotton swab. At the end of the ninth day, the leaves were debladed, keeping the length of the petiole at 1½" and 0·1 ml. of a 10^{-2} M concentration of DL methionine, or DL alanine was applied in glass capillaries to debladed petioles. The time taken for 50% abscission was determined by taking observations every day at 8 a.m. and 5 p.m. The experiment was repeated four times with similar trends and the data of one experiment are given in Table I.

TABLE I

Time taken for 50% abscission of debladed petioles following different treatments in Coleus blumei, *Benth.*

Pre-treatment of leaves	Solution applied to debladed petioles			
	Water	Methionine	Alanine	IAA
Water ..	72·5	31·2	39·0	129·1
Benzyl adenine ..	110·0	50·4	87·0	226·0
Kinetin ..	61·7	50·4	63·0	154·0

The effect of application of 0·1 ml. of a 5 × 10^{-5} M concentration of IAA on abscission of debladed petioles with different pre-treatments to the leaves was also studied.

It can be seen from the data that both the amino-acids have an accelerating effect on abscission of debladed petioles. The time taken for 50% abscission when methionine is applied is 31·2 hrs., with alanine it is 39 hrs., while in the control it is 72·5 hrs. Prior treatment of leaves with BA has resulted in partly suppressing the accelerating effect of these amino-acids. The time taken for 50% abscission with application of methionine is 50·4 hrs. when BA or kinetin is used for pre-treatment and 31·2 hrs. when distilled water is given as pre-treatment. Similarly, when alanine is applied, following a pre-treatment of leaves with BA and kinetin, the time taken for 50% abscission is 87 and 63 hrs. respectively, while it is 39 hrs. when leaves are pre-treated with distilled water.

It is thus clear that the accelerating effect of amino-acids methionine and alanine on abscission of debladed petiole is mitigated by a prior treatment of leaves with cytokinins. In view of the known effect of cytokinins on RNA and protein synthesis,[7] it is possible that the enhanced protein synthesis may be causing greater incorporation of the applied amino-acids and consequently the promotive effect of these on abscission are mitigated. The other interesting point is that the extent to which the accelerating effect of amino-acids is mitigated varies with the cytokinin and the amino-acid. The maximum effect is observed with prior treatment of leaves with BA followed by application of alanine.

Prior treatment of leaves with cytokinins has also resulted in enhancing the delaying effect of IAA on abscission. This confirms the earlier observations made with benzyl adenine only.[1]

We are grateful to Dr. N. P. Patil, Director of Research, for his encouragement.

Plant Physiol. Sec., — D. P. Viswanath.
Univ. of Agric. Sci., — K. M. Appaiah.
Bangalore-24, — S. Rama Rao.
September 17, 1970. — K. S. Krishna Sastry.

---

1. Krishna Sastry, K. S. and Rama Rao, S., *Mysore J. Agric. Sci.*, 1967, **1**, 259.
2. Nooden, L. D. and Thimann, K. V., *Plant Physiol.*, 1965, **40**, 193.
3. Klein, R. M. and Edsall, P. C., *Ibid.*, **1967**, **42**, 461.
4. Valdovinos, J. G. and Earnest, C. L., *Physiol. Plant*, 1967, **20**, 1027.
5. Yager, R. E. and Muir, R. M., *Science*, **1958**, **127**, 82.
6. Valdovinos, J. G. and Muir, R. M., *Plant Physiol.*, 1965, **40**, 335.
7. Letham, D. S., *Ann. Rev. Plant Physiol.*, 1967, **18**, 349.

A LEAF SPOT OF *ACROCARPUS FRAXINIFOLIUS* W.

Acrocarpus fraxinifolius W. is a common shade plant grown in the coffee and cardamom areas in South India. During my investigations on the leaf-rot of cardamom caused by ***Phaeodactylium Venkatesanum*** Agnihothrudu in Malabar Wynaad, I came across a leaf spot of *Acrocarpus fraxinifolius* W. both in the main fields where it is used as a shade as well as in the seedling nurseries of this shade plant. The fungus was found to be a new species of *Cercospora* **which is described below:**

Cercospora acrocarpicola Agnihothrudu, sp. nov.

Leaf spots circular to irregular 3–10 mm. in diameter, reddish-brown, sometimes with pale brown to greyish centre. Fruiting hypophyllous, stromata dark olive-green, globular upto 40 μ in diameter, fascicles dense, conidiophores pale olivaceous or subhyaline, uniform in **colour, slightly tapering,** apically smooth, straight or gently undulate, 1–3 septate, unbranched with a conical tip, measuring 15–30 (–36) 3–4·5 (–5) μ; conidia subhyaline to dilute olivaceous, obclavate, cylindric, smooth-walled, straight or slightly sinuous, distinctly 2–4 (–5) septate with a subtruncate base and a rounded to conic tip measuring 35–60 (–64) × 3–4 (–5) μ.

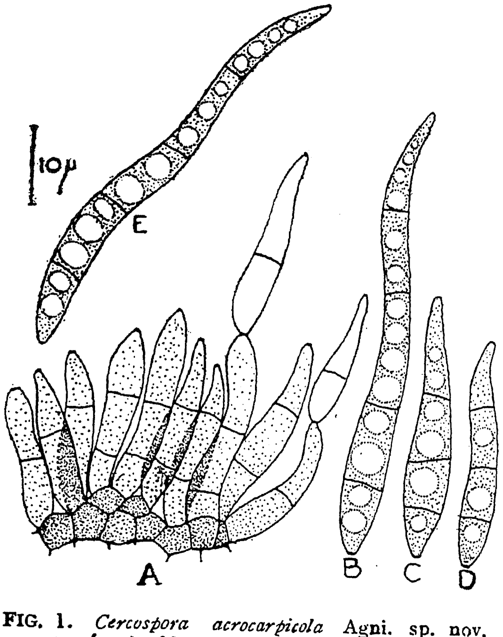


Fig. 1. *Cercospora acrocarpicola* Agni. sp. nov. on *Acrocarpus fraxinifolius* W.

A—Conidiophores; B, C, D, E—Conidia.

Type on living leaves *Acrocarpus fraxinifolius* W. collected at Chulika Estate, Malabar Wynaad, Kerala, dated 14-5-1970, by V. Agnihothrudu, deposited in the Mycological Herbarium, Rallis India, Ltd., under No. 12.

Cercospora acrocarpicola Agnihothrudu sp. nov.

Foliorum maculae ciculares vel irregulares 3–10 mm. diam., rubiginosae, quandoque versus centrum pallide brunneae vel griseae. Stromata fructifera hypophylla, atro-olivacea, globularia, usuue 40 μ diam., fasciculi conferati; conidiophora pallide olivacea vel subhyalina, uniformiter colorata, parum versus apicem attenuata, laevia, recta vel leviter undulata, 1–3 septata, haud ramosa, apice conico, 15–30 (–36) × 3-4·5 (–5) μ. Conidia subhyalina vel pallide olivacea, obclavata, cylindrica, parietibus laevibus, recta val paulo sinuata, distincte 2–4) (–5) septata, basi subtruncata et apice ritundato vel concideo, 35–60 (–64) × 3·4 (–5) μ.

Typus supra folia viventia *Acrocarpi fraxinifolii* W. die 14 mensis maii 1970 ab V. Agnihothrudu ad praedam Chulika, Malabar Wynaad, Kerala, lectus et in herbario mycologico Rallis India Ltd., sub numero 12 positus est.

I am grateful to Mr. D. K. Ghandhi, Director, Rallis India Limited, for permitting me to publish this article, to Rev. Cecil J. Saldanha for rendering the Latin diagnosis, to Mr. R. A. Padmanathan, Chief Executive, M/s. A. V. Thomas and Company, for arranging my visit, and to Mr. Patrick John, for taking me round Chulika Estate.

Fertiliser and Pesticides Division,
Rallis India Ltd., P.B. No. 168,
Bangalore-1 B, *September* 10, 1970.
V. Agnihothrudu.

PECTIC AND CELLULOLYTIC ENZYMES OF *XANTHOMONAS MALVACEARUM*, THE INCITANT OF BACTERIAL BLIGHT OF COTTON

Pectic and cellulolytic enzymes have been shown to be involved in the pathogenesis of several fungi and bacteria.[1–6] There has been some controversy regarding the production of pectic enzymes by *Xanthomonas malvacearum* (E. F. Smith) Dowson, the causal organism of bacterial blight of cotton in *in vitro* condition.[7] This was due to the failure to recognise the adaptive (induced) nature of enzyme production. Abo-El-Dahab[7] reported abundant pectinmethylesterase (PME) formation by five isolates on basal medium + pectin, whereas it was absent on BM + sucrose. We have a large collection of isolates of *X. malvacearum* and selected races[8] 10 and 3 for enzymatic studies with a view to elucidating their rôle in pathogenesis.

The cultures were grown on nutrient broth (NB) and NB + pectin (P) at 28° C. for 48 hrs. after which they were centrifuged at 12,000 r.p.m. for 45 min. and the clear supernatant was directly used as the crude extracellular enzyme extract. The enzyme activities are given in Table I.

Table I

Pectic and cellulolytic enzymes of two races of Xanthomonas malvacearum

Race No.	Medium	Cellulase*	Macerating enzyme			
			Potato disc method†	Colorimetric method‡		
				Water	Na^+	Ca^{++}
3	NB	35·5	–	0·01	0·01	0·14
3	NB+P	46·9	+	0·04	0·03	0·36
10	NB	58·2	–	0·03	0·05	0·30
10	NB+P	12·3	+	0·03	0·03	0·27

* Per cent. reduction in viscosity of 0·6% carboxymethyl cellulose in 4 hours, † Loss in coherence of turgid potato discs (1 mm. thick and 12 mm. in diametre) at the end of 72 hours. Maceration was earlier in race 10, ‡ Reaction mixture: 5 ml. pectin (1%) containing 0·1 M $CaCl_2$ or 0·01 N NaCl + 5 turgid potato discs; incubated at 35° C. for 24 hours. Requirement of Ca^{++} is shown.

Both the isolates produced the macerating enzyme only on NB + pectin medium, when the loss in coherence of potato discs was used to determine the enzyme activity. Maceration was earlier in race 10, which goes on 7 of the 8 differentials,[8,9] while race 3 goes on only 4 differentials.[9] Race 10 is also more widely distributed.[8,10] When the macerating enzyme activity was studied by a colorimetric technique,[2] it was confirmed that race 10 produced greater amount of macerating enzyme. Further, it was shown that the enzyme was produced both on NB and NB + P to more or less similar extent by race 10, whereas race 3 produced appreciable quantity only on NB + P, thereby showing a strain differentiation in the capacity for producing the enzyme. It is also indicated that probably colorimetric method is better than the potato disc method to determine macerating enzyme activity.

Cellulase activity was present in both the races to quite an appreciable degree on both the media, *i.e.*, NB and NB + P.

Attempts to show the presence of transeliminase activity have failed so far. Both the isolates reduced the viscosity of 1% pectin solution and also released some methoxy groups on both the media indicating that both PG (polygalacturonase) and PME are present. Work is now in progress to identify the individual PG and will be published shortly.

The authors are grateful to Dr. S. P. Raychaudhuri, Head, Division of Mycology and Plant Pathology, for his keen interest and advice.

Division of Mycology and Plant Pathology, I.A.R.I., New Delhi, *September* 11, 1970.
J. P. Verma.
R. P. Singh.

---

1. Smith, W. K., *J. gen. microbiol.*, 1958, **18,** 33.
2. Wood, R. K. S., *Ann. appl. Biol.*, 1960, **49,** 120.
3. Verma, J. P., *Bull. Bot. Soc., Bengal,* 1964, **18,** 149.
4. Cole, A. L. J. and Bateman, D. F., *Phytopathology*, 1969, **59,** 1750.
5. Dasgupta, S. N., *Ind. Phytopathology*, 1969, **22,** 28.
6. Mussell, H. W. and Green, R. J. Jr, *Phytopathology*, 1970, **60,** 192.
7. Abo-El-Dahab, M. K., *Ibid.*, 1964, **54,** 597.
8. Verma, J. P. and Singh, R. P., *Curr. Sci.*, 1970, **39,** 20.
9. Hunter, R. E., Brinkerhoff, L. A. and Bird, L. S., *Phytopathology*, 1968, **58,** 83.
10. Verma, J. P. and Singh, R. P., *Empire Cott. Gr. Rev.*, 1970, **47** (In press).

TRIPLE TRISOMIC IN PEARL MILLET

Addition of extra chromosomes to a complement results in reduced plant vigour, and tolerance of only two to four extra chromosomes has been reported in sugarbeet,[3] *Sorghum*[4] and barley.[5]

Among the progenies of open pollinated triploid plants of pearl millet ($2n = 14$), two plants out of 273 were reported to possess $2n + 1 + 1 + 1$ chromosomes.[1] Detailed study on cytological behaviour was possible only in one of these plants. PMCs were fixed in acetic alcohol (1 : 3) for meiotic studies. Triple trisomics were less vigorous and shorter in size than the controls.

The observations on plant height, leaf width and time taken for the initiation of flowering are recorded in Table I. General reduction in size of various plant parts in pearl millet trisomics was observed.[2] However, when compared with trisomics, triple trisomics are not further reduced in size indicating that the dosage effect of the extra chromosomes involved is not cumulative.

Table I

Comparison of morphological characteristics of triple trisomic plants with diploid

Material	Height (cm.)	Leaf width (cm.)	Days to flower
23-9 ($2n$+1+1+1) ..	33·0	0·8	92
24-12 ($2n$+1+1+1) ..	55·0	1·5	97
BIL-4 ($2n$) ..	122·4	2·9	80

Presence of $2n + 1 + 1 + 1$ chromosomes is shown in Fig. 1. The cytological behaviour at diakinesis is reported in Table II. Chromosome association of $1_{III} + 6_{II} + 2_{I}$ at diakinesis was observed in 48% PMCs. Other associations, *viz.*, $2_{III} + 5_{II} + 1_{I}$, $3_{III} + 4_{II}$ and $7_{II} + 3_{I}$ were observed in 23·9 and 20% PMCs respectively.

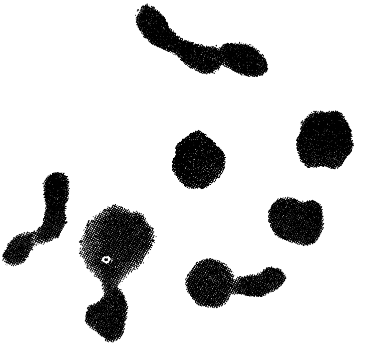


Fig. 1. A cell showing $3_{III} + 4_{II}$ (×2,500).

Table II

Chromosome associations (%) at diakinesis in triple trisomic (24–12)

$3_{III}+4_{II}$	$2_{III}+5_{II}+1_{I}$	$1_{III}+6_{II}+2_{I}$	$7_{II}+3_{I}$	Total cells studied
9·0	23·0	48·0	20·0	100

Distribution of 9–8 was the most frequent at anaphase I. At telophase II, 68% microspores had no micronuclei and presence of 1, 2 and 3 micronuclei was observed in 26, 5·5 and 0·5% microspores respectively.

There was no seed-setting in these triple trisomic plants. Therefore, they could not be maintained. More than three extra chromosomes have not been found in pearl millet so far. Probably this is the limit of tolerance of extra chromosomes for survival.

Dept. of Genetics, Punjab Agric. University, Ludhiana, *September* 9, 1970.
B. S. Gill.
S. S. Virmani.

---

1. Gill, B. S., Virmani, S. S. and Minocha, J. L. "Aneuploids in pearl millet," *Experientia*. 1970, **26,** 1021.
2. —, — and —, "Primary simple trisomic in pearl millet," *Canad J. Genet. Cytol.*, 1970 (In press).
3. Levan, A, "The effect of chromosomal variation in sugarbeets," *Hereditas*, 1942, **28,** 345.
4. Price, M. E. and Ross, W. M., "Cytological study of a triploid × diploid cross of *Sorghum vulgare* Pers." *Agron. J.*, 1957, **49,** 237.
5. Tsuchiya, T., "Studies on cross compatibility of diploid, triploid and tetraploid barley. III. Results of 3*x* × 3*x* crosses," *Sicken Ziho*, 1960, **11,** 29.

REVIEWS AND NOTICES OF BOOKS

Basic Laser Raman Spectroscopy. By Jack Loader. (Published by Heyden and Son Ltd., Spectrum House, Alderton Crescent, London, N.W. 4), 1970. Pp. 105. Price £1·18·0, $4.50, DM 18.00.

The discovery of the laser and its development as a powerful source of monochromatic radiation has led to a renewal of interest in Raman spectroscopy. New Raman spectrometers using laser sources are being made commercially available with continually improving efficiency of performance. These developments show promise of laser Raman spectrometry becoming an essential tool in the hands of chemists, next to infrared spsctrometer, for "fingerprinting" organic compounds.

This little manual, very neatly got up, will serve as a handy aid to practical chemists who are taking to this new field of Raman organic analysis.

The Raman effect is explained in simple language and there are sections devoted to sample handling, and instrumental features like calibration, resolution, intensity factors, etc. Description and performance of available lasers and LR spectrometers are included. Laser Raman Charts of about twenty solvents of importance as they are recorded on a Cary 81 LR spectrometer, with relevant data, are the chief attraction in the book. A. S. G.

A New Technology for Dry Land Farming. (Published by the Indian Agricultural Research Institute, New Delhi), 1970. Pp. iv + 190. Price Rs. 5; $1.00 or 8 *sh.* (postage extra).

The Indian Agricultural Research Institute (IARI), New Delhi, is deeply concerned with the application of modern developments in science and technology to the varied problems of agriculture in the country, and with the task of carrying the results of research in the laboratory to the farmers in the fields. One of these problems, and a major one in that it leads to rural prosperity is dry land farming. This is concerned with farming in areas which receive low rainfall, 400–1,000 mm. annually, and do not have adequate irrigation facilities. They constitute nearly 40% of the net sown area in the country and cover about 50 million hectares.

The present publication brings together some of the significant results of recent research work done at the IARI on dry land farming. The topics dealt with include soil properties and crop growth, soil management and moisture conservation, tailoring new crop varieties for dry areas, agronomic practices, supply of nutrients, plant protection, etc. A. S. G.

Elements of Quantum Theory. By Frank J. Bockhoff. (Addison-Wesley Publishing Company, Inc., West End House, 11 Hills Place, London, W. 1, England), 1970. Pp. 304. Price 43 *sh.*

This text is intended to be a first introduction to the concepts, postulates, and applications of quantum theory using the wave mechanical approach. The author has chosen to consider with relative rigour and thoroughness a limited number of concepts and applications which provide a coherent framework for further development. Thus, the first three chapters are devoted to blackbody radiation, the photoelectric effect, and Bohr theory of the hydrogen atom. The postulates of quantum mechanics are developed and applied to single particle and then to simple systems. Hydrogen and helium atoms are dealt with in detail. The last two chapters deal with more complex atoms and molecules.

The book is suitable for graduate course students in physics. Scientists and engineers who desire to study quantum mechanics independently will also find the book useful.

A. S. G.

Introductory Books on Probability. (Published by Addison-Wesley Publishing Co., Inc., West End House, 11 Hills Place, London W. 1), England.)

Finite Probability. By Michael Gemignani. Pp. 122.

This booklet presents a self-contained step-by-step development of the theory of probability for finite sample spaces. It may also be used as an introduction to formal mathematical systems. Basic notions of the theory are clearly explained and the reader can also get an insight into what mathematics is and how it works. High school algebra is the only prerequisite on the part of the student reader.

Probability and Calculus. By John B. Fraleigh. Pp. 250. Price 75 *sh.*

This text will serve as an introduction on set theory and probability and on analytic geometry and calculus. The treatment is covered under chapters: Sets and Counting; Probability; Real Analytic Geometry; Functions; Differential Calculus; Integral Calculus.

It is assumed that the student has had a year of high school algebra and geometry. The book is intended for a single semester course on the subjects at college level.

A. S. G.

Animal Blood Groups and Biochemical Polymorphism. (XI European Conference Proceedings). (Dr. W. Junk, Publishers, 13, Van Stolkweg, The Hague, The Netherlands), 1970. Pp. xxii + 608. Price Dutch Guilders 60; U.S. $16.65.

The volume contains the reports, discussions and lectures of the XI European Conference on Animal Blood Groups and Biochemical Polymorphism, which was held in Warsaw, July 2nd-6th, 1968, and in which 150 participants took part.

The ninety-six papers in this publication are grouped under the following headings according to the animals concerned: Chapter I: Blood Groups and Biochemical Polymorphism in Cattle (27 papers); II: in Pigs (22 papers); III: in Poultry (14 papers); IV: in Horse (9 papers); V: in Sheep and Goat (8 papers); VI: in Fish (4 papers); VII: Blood Groups and Histocompatibility in Mouse, Rat and Coypu (5 papers); and VIII: Correlations Between Blood Groups and Other Traits (7 papers).

There are 196 tables and 75 figures.

A. S. G.

Biochemistry of Antibodies. By Roal'd S. Nezlin. (Published by Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011, U.S.A.). Pp. 381, Price $25.00.

This is the English translation, corrected by the author, of the original Russian text published in 1966.

Antibody synthesis is one of the most important protective mechanisms against infections. Antibodies also account for reactions of hypersensitivity, which play a leading role in the development of pathological processes. Thus, they have been of interest not only to microbiologists and immunologists, but also to physicians who found in these proteins an extremely powerful and specific therapeutic agent.

A wealth of data on antibodies has been obtained in research laboratories throughout the world, and it is time for a detailed critical analysis of these data. That is what the author does in this book.

The contents of the book are covered under the following chapter headings: I. Quantitative Methods for Determination of Antibodies; II. Isolation of Pure Antibodies; III. Properties of Antibodies; IV. The Structure of Antibodies; V. Antibody Biosynthesis; VI. Genetic Aspects of Antibody Synthesis; VII. Theory of Antibody Synthesis.

The book formulates the important unsolved problems and indicates the necessary directions for future research. Extensive references are appended to each chapter.

A. S. G.

Books Received

Molecular Mechanisms in Memory and Learning. Edited by G. Ungar. (Plenum Publishing Corporation, 114, Fifth Avenue, New York 10011), 1970. Pp. xiv + 296. Price $15.00.

Total Steroid Synthesis. By A. A. Akhrem, Yu A. Titov. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xi + 362. Price $25.00.

Impurity Spectra of Solids. By K. K. Rebane. (Plenum Publishing Corporation, 114, Fifth Avenue, New York 10011), 1970. Pp. xvi + 253. Price $19.50.

Volcanism and the Upper Mantle Investigations in the Kurile Island Arc. By G. S. Gorshkov. (Plenum Publishing Corporation, 114, Fifth Avenue, New York 10011), 1970. Pp. xv + 385. Price $35.00.

Programming and Computer Technique in Experimental Physics. Edited by Academician D. V. Skobel'tsyn. (Plenum Publishing Corporation, 114, Fifth Avenue, New York 10011), 1970. Pp. vi + 126. Price $15.00.

Topics in Mathematical Geology. Edited by M. A. Romanova and O. V. Sarmanov. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. viii + 281. Price $37.50.

Blood Oxygenation. Edited by Daniel Hershey. (Plenum Publishing Corporation, 114, Fifth Avenue, New York 10011), 1970. Pp. x + 374. Price $17.50.

2487-70. **Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, L.P.T., Superintendent, at The Bangalore Press, Bangalore-18.**

ALKALINE EARTH ELEMENTS IN MARINE SEDIMENTS OFF TARAPUR COAST

S. R. RAO AND S. M. SHAH
Health Physics Division, Bhabha Atomic Research Centre, Bombay

WITH the release of radioactive materials to the sea, there is very marked uptake of radioactivity by bottom sediments and marine organisms. Organic material produced by the detrital material resulting from the disintegration of marine organisms and also from influx of terrestrial materials, etc., concentrate at the bottom. Bottom organic detritus is considered the source of nourishment for benthic invertebrates[1] and these benthos are utilised as food for human consumption. The larger benthic forms ingest the sediment, causing mechanical abrasion of the solid particles and acceleration of the solution of such materials as calcium carbonate by their stomach fluids which are somewhat acidic.

Even though the water concentration may be below maximum permissible level, some bottom living organisms may accumulate considerable amount of radioactivity through their food habits. Crozier[2] has calculated that Stichopus (Sea cucumbers), in certain shallow coastal areas of Bermuda, pass 6 to 7 kg. (dry wt.) of mud per square metre per year through their digestive tracts ; in a certain enclosed area of 1·7 mi^2 the mud eaten annually may be from 500 to 1,000 tons.

Different isotopes of the same element generally behave identically, the degrees at which a given radio-isotope is taken up and retained by an organism depends to a large extent on the amount of the stable isotope of the same element present in the environment. Also, elements closely related to each other in their ionic properties will tend to behave similarly and thus simulate isotope dilution. Thus, the uptake of strontium-90 which is an important fission product having a high fission yield is guided both by the stable strontium and calcium present in the environment which is utilised by the organisms, *i.e.*, the leachable portion present in the sediment. Thus, it is very important to study the leachable part of strontium and calcium present in the sediment in order to study the uptake of Sr-90 by benthic organisms.

As regards Ra-226, it contributes a significant part of our environmental alpha activity and is important as it is closely in equilibrium with animal body.[3]

Sarma *et al.*[4] have extensively analysed sediments, sea-water and biomaterial samples off Tarapur coast for content of major and trace elements and natural radioactivities. They have given the values for the various elemental contents in the marine sediments after leaching with N/20 HCl, 5% EDTA, 1 N ammonium citrate and 1 N ammonium acetate but values for the different elements in sediments are not given after total decomposition in order to find out the leaching capacities of the leaching reagents used.

In the present work, premonsoon sediment samples collected off Tarapur coast were decomposed completely and analysed for Ra-226, calcium and strontium contents and the data obtained are compared with those reported for different leaches.

METHOD

Sediment samples were oven-dried at 100–110° C. and 10 gm. of the sample were taken in a platinum dish (150 ml. capacity) and heated to 400° C. in an electric muffle furnace to destroy the organic matter present. After cooling the dish, it was treated with 80 ml. of nitric acid (3 N) and boiled. The leachate was centrifuged off and transferred to a 250 ml. pyrex beaker. The residue was transferred back to the platinum dish and dried. To the dried residue, 25 ml. of perchloric acid (60%) and 50 ml. of hydrofluoric acid (40%) were added and the acids evaporated to dryness. The treatment with perchloric acid and hydrofluoric acid was repeated twice. The perchlorates of elements left after the above treatment were dissolved in 2 N hydrochloric acid and filtered through Whatman No. 42 filter-paper. In order to decompose any residue left after the above treatment, the paper and the residue were placed in the platinum dish and heated to dull redness to destroy the paper. Residue in the platinum dish was treated with about 4 times its weight of sodium carbonate and fused at 900° C. in the muffle furnace. After cooling the dish, the solid was washed five times with 10 ml.

portions of distilled water and washings were discarded. Insoluble fraction was treated with nitric acid (3 N) and extract transferred to the original beaker.

Any insoluble portion that still remained was given hydrofluoric-perchloric acid treatment followed by sodium carbonate fusion. The final solution was made up to 250 ml. and aliquots of this solution were taken for the determination of Ra-226, strontium and calcium.

Radium-226.—Radium was determined after coprecipitation with barium sulphate.[5]

Strontium.—Strontium was precipitated as oxalate and determined by atomic absorption spectrophotometry using method of addition.[6]

Calcium.—Calcium was precipitated as oxalate and determined titrimetrically using standard EDTA-Mg solutions.[7]

Results and Discussion

The values for radium-226, strontium and calcium after total decomposition of the sediments are given in Table I. Table II represents the values of the elements in sediments obtained by various leaching agents. From these data, it is seen that calcium is leached 89–100% by HCl, 56–100% by EDTA, 55–97% by citrate and 23–56% by acetate leach. For strontium, the corresponding values are 70–100% by HCl, 35–75% by EDTA, 12–83% by citrate and 23–79% by acetate.

TABLE I

Radium-226, strontium and calcium content in sediment after total decomposition

Sample No.	Location		Ra-226 μg. atom × 10^{-9}/g.	Sr μg. atom/g.	Ca μg. atom/g.
6T	19° 55·4′ N	72° 28·3′ E	2·89	1·23	430
10T	19° 47·2′ N	72° 37·9′ E	3·37	1·29	428
11T	19° 44·9′ N	72° 36·4′ E	2·95	0·93	420
12T	19° 42·2′ N	72° 34·9′ E	4·10	1·39	525
13T	19° 39·4′ N	72° 33·4′ E	3·31	1·55	436
14T	19° 43·8′ N	72° 28·5′ E	..	1·39	440
16T	19° 46·9′ N	72° 34·0′ E	4·17	1·24	560
18T	19° 50·0′ N	72° 34·2′ E	4·37	..	488

As regards radium, the values obtained are 23–80% for HCl, 12–31% for EDTA, 5–17% for citrate and 2–8% for acetate leach.

Goldberg and Arrhenius[8] have used a technique which involves the preferential EDTA chelative dissolution of the sediment. This process was designed to remove the readily soluble phases of the sediment leaving the minerals as intact as possible. According to these authors, such a treatment would be expected to attack trace elements adsorbed onto the surface of the clay minerals but would leave the lattice structure of clay minerals of igneous rocks intact. In the present investigation, it is observed in case of radium, that EDTA removes only 12–31% of radium from the sediments. This indicates that most of the radium is firmly held in the crystal lattice of these sediment particles.

TABLE II

Ra-226, Sr and Ca contents in various leachates and % leached of the total

		Ra-226		Sr		Ca	
Sample	Leach	μg. atom × 10^{-9}/gm.	% leached	μg. atom/g.	% leached	μg. atom/g.	% leached
6T	HCl	0·81	28	1·28	104	434	101
	EDTA	0·82	28	0·91	74	430	100
	Amm. citrate	0·50	17	0·60	49	235	55
	Amm. acetate	0·09	3	0·34	28	200	47
10T	HCl	0·78	23	1·28	99	434	101
	EDTA	0·59	18	0·81	63	312	7[illegible]
	Amm. citrate	0·26	8	0·60	47	409	96
	Amm. acetate	0·16	5	0·38	29	200	47
11T	HCl	2·36	80	0·91	98	374	89
	EDTA	0·41	14	..	..	430	102
	Amm. citrate	0·50	17	0·77	83	409	97
	Amm. acetate	0·09	3	0·21	23	235	56
12T	HCl	2·25	55	1·28	92	557	106
	EDTA	0·82	20	1·04	75	441	84
	Amm. citrate	0·29	7	..	..	476	91
	Amm. acetate	0·31	8	1·10	79	235	45
13T	HCl	1·99	60	1·45	94	434	100
	EDTA	1·04	31	0·54	35	416	95
	Amm. citrate	0·34	10	0·30	19	409	94
	Amm. acetate	0·09	3	0·45	29	225	52
14T	HCl	..	..	1·10	79	434	99
	EDTA	..	..	0·57	41	457	104
	Amm. citrate	..	..	0·17	12	..	..
	Amm. acetate	..	..	0·41	29	102	23
16T	HCl	1·67	40	1·10	89	559	100
	EDTA	1·06	25	0·46	37	312	56
	Amm. citrate	0·32	8	..	..	447	80
	Amm. acetate	0·15	4	0·38	31	21[illegible]	37
18T	HCl	1·98	45	..	..	499	102
	EDTA	0·53	12	..	..	462	95
	Amm. citrate	0·23	5	..	..	409	84
	Amm. acetate	0·10	2	..	..	172	35

ACKNOWLEDGEMENT

Authors wish to express thanks to Dr. A. K. Ganguly for his valuable guidance, and to Dr. R. Viswanathan for his encouragement in carrying out this work. Thanks are also due to Shri K. C. Pillai for going through this paper critically.

---

1. Sverdrup, H. U., Johnson, M. W., and Fleming, R. H., *The Ocean*, Asia Publishing House, 1962, ed., p. 893.
2. Crozier, W. J., *Jour. Exper. Zool.*, 1918, **26**, **379**.
3. Hallden, N. A., Fisenne, I. M. and Hartley, H. H., *Science*, **1963**, **140**, **1327**.
4. Sarma, T. P. *et al.*, *Bulletin of the Nat. Inst. of Sciences of India*, **1968**, No. **38**, Part 1, p. **308**.
5. Goldin, A. S., *Anal. Chem.*, 1961, **33**, 406.
6. Viswanathan, R., Shah, S. M. and Unni, C. K., *Bulletin of the Nat. Inst. of Sciences of India*, 1968, No. 38, Part 1, 284.
7. Henly, A. A. and Saunders, R. A., *Analyst*, 1958, **83**, 584.
8. Goldberg, E. D. and Arrhenius, G. O. S., *Geochim. et Cosmoch. Acta*, 1958, **13**, 153.

PREPARATION OF BIXIN AND METHYL BIXIN FROM INDIAN SEEDS OF *BIXA ORELLANA*

C. P. BAHL, T. R. SESHADRI AND T. N. C. VEDANTHAM
Department of Chemistry, University of Delhi, Delhi-7, India

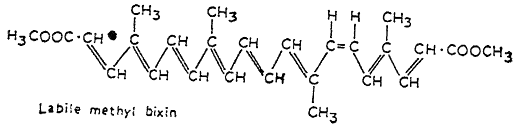
BIXA ORELLANA is a shrub in Central and South America, and in India it grows into a tree. The plant is commonly associated with the Annatto dye obtained from the seeds; its earlier use for dyeing of fabrics has ceased with the development of synthetic dyes. Bixin is the main component and this is at present in considerable demand as a non-toxic fat-soluble food colour.

In the earlier method of isolation of Bixin,[1] the seeds were stirred with water for a few hours and filtered through a sieve in order to obtain crude annatto preparation which was later purified. The extraction is not efficient because the outer red coating of colouring matter is not detached fully even after shaking with water for six hours in a machine. Boiling the seeds with water brings in many impurities. Direct extraction of the seeds seemed to offer better possibilities and we have examined the use of various solvents. Further, a careful physical examination of the seeds showed that the seed-coat is quite hard and non-porous, that the kernel is also hard and the pigment is entirely on the seedcoat. Therefore, it is most convenient to extract the entire seeds without powdering; this reduces the difficulty of filtration of the extracts, and the extraction of other components present in the kernel. Petroleum ether and ether are not satisfactory as solvents; the best extraction could be carried out by means of acetone or ethyl acetate. Extraction in a Soxhlet apparatus is slow; direct boiling in a flask and decanting the extract through cotton is found to be most convenient. A typical experiment is given below:

The seeds of *Bixa orellana* (200 g.) were directly boiled with ethyl acetate (2 × 500 ml.), the solution decanted and concentrated. It deposited about 2·2 g. of pure crystalline labile bixin which was filtered off. The filtrate was poured into excess of petroleum ether with vigorous stirring, when 1·8 g. of a deep red solid was precipitated; it was filtered and mother liquor marked (A). On TLC, using silica gel as the adsorbent and employing the solvent ($CHCl_3$–MeOH, 94 : 6) for developing the chromatogram, the solid was found to be mainly bixin with a small amount of deep orange impurity that did not move. Purification could be effected by taking the ethyl acetate solution of the solid and diluting it with petroleum ether, when pure bixin (1·5 g.) was precipitated. The mother liquor (A) obtained earlier was concentrated. The solid residue (5·2 g.) obtained was taken up in ether and separated into alkali-soluble and neutral portions. The alkali-soluble portion, after acidification followed by column chromatography over silica gel yielded some more of bixin (0·8 g.).

Thus, labile bixin was obtained as red prismatic needles, m.p. 197–99°, $\lambda_{max.}^{CHCl_3}$ 502 (log ϵ, 4·49), 471 (4·46) and 446 (4·35) nm.; $\nu_{max.}^{KBr}$ 3300 (broad), 1725 (s), 1660 (w), 1615 (m), 1575 (s), 1430 (w), 1290 (m), 1260 (m), 1210 (m), 1165 (s), 1010 (w) and 965 (s) cm.$^{-1}$ It gave cornflower blue colour when treated with concentrated H_2SO_4.

Following the earlier procedure,[2] labile bixin has been converted into its methyl ester by shaking its solution in methanolic potassium hydroxide with dimethyl sulphate. It is better prepared in good yield by the easier method of refluxing the acetone solution of bixin with dimethyl sulphate and potassium carbonate. After filtering off the potassium salts, the solution is concentrated, stirred with excess of water and allowed to stand when the crystalline labile methyl bixin is obtained. The ester is also easily formed when bixin is treated with ethereal diazomethane. It is obtained as red plates, m.p. 161–62°, $\lambda^{CHCl_3}_{max.}$ 502 (log ϵ, 2·72), 472 (2·79) and 446 (2·65) nm ; $\nu^{KBr}_{max.}$ 1720 (s), 1650 (w), 1615 (s), 1560 (m), 1430 (w), 1310 (s), 1290 (m), 1265 (s), 1190 (m), 1165 (s), 1010 (m), 985 (m), and 965 (s) cm.$^{-1}$ This gives a blue colour with conc. H_2SO_4.



Labile methyl bixin

The nmr spectrum of labile methyl bixin in $CDCl_3$ showed a broad signal at 1·98 δ (12 H) indicative of four C-Methyl protons. A sharp singlet at 3·77 δ (6 H) was due to the protons of the two carbomethoxyls. In the olefinic region, a broad band centred at 6·57 δ (10 H) was observed. Apart from this, there were three doublets, each centred at 5·89 (2 H), 7·41 (1 H) and 7·98 δ (1 H). The first doublet belongs to the 2 α protons merging together and the β protons differ, one being at 7·41 and the other at 7·98 δ. Barber *et al.*[3] have earlier compared the nmr spectra of labile and stable methyl bixin. They noted that the two spectra agreed in all respects except one. In the stable methyl bixin, both the β-protons gave the same signal at 7·39 δ (2 H). The shifting of a β-proton in labile methyl bixin by 0·56 δ to the lower field was attributed to the proximity of the β-proton at one end of the molecule to the *cis* 6, 7 double bond. Thus, the nmr supports earlier fixation of the *cis* double bond by chemical methods.[4]

The greater solubility of methyl bixin in fats and fat solvents as compared to bixin which is rather sparingly soluble would suggest the use of ester as more suitable for colouring butter. Further, it will not add to the acid value of the butter. By the simplified method given above, it is very easily prepared. However, its tinctorial value is poor ; though $\lambda_{max.}$ is the same as for bixin, log ϵ is markedly low and hence it is not suitable.

---

1. Kuhn, R. and Ehmann, L., *Helv. Chim. Acta*, 1929, **12**, 904.
2. Van Hasselt, J. F. B., *Rec. Trav. Chim. Pays. Bas.*, 1911, **30**, 8.
3. Barber, M. S., Hardisson, A., Jackman, L. M. and Weedon, B. C. L., *J. Chem. Soc.*, 1961, p. 1625.
4. Karrer, P. and Solmssen, U., *Helv. Chim. Acta*, 1937, **20**, 1396.

INHERITANCE OF 'DYE BINDING CAPACITY' VALUE IN RICE

C. B. SINGH, S. ARORA AND A. K. KAUL
Indian Agricultural Research Institute, New Delhi-12

RECENT work done at the International Rice Research Institute[1] and at the Indian Agricultural Research Institute[2] has convincingly proved that, in rice, considerable genetic variation exists for protein content and quality. A number of high protein genotypes have been identified at both places in the world germplasm collection. However, before such variation can be profitably exploited the estimation of heritability and the gene control mechanisms should be worked out under varying conditions to gain maximum genetic advance, through hybridization. Although numerous such studies have been performed in wheat,[3-6] there is no report available in rice on this aspect. In the present study, an attempt was made to evaluate the inheritance of protein quality and quantity using the micro dye binding technique described earlier.[7] The single grains of F_2 populations, derived from single plants from crosses between Tainan-3 × IR-8 (*japonica* × *indica* of subsp. *Oryza sativa*) and IR-8 × Basmati-370 (*indica* × *indica*) were studied along with their respective parents. Means and variances were obtained and the frequency distribution was plotted (Fig. 1). Parental variances were used to estimate the environmental component of variation. Before the data was used for estimating the heritability, scale was tested.[8] Means, vari-

TABLE I

Means, variances, heritability and genetic advance in two crosses

Generation	N	Mean (X)	Variance (V)	Heritability (h^2)	Genetic advance G_A
P_1 (Tainan-3)	48	0·143	0·00061	..	..
P_2 (IR-8) ..	51	0·160	0·00028	..	..
P_3 (Basmati-370)	48	0·176	0·00057	..	..
$P_1 \times P_2$ (F_2 population)	96	0·220	0·00089	50·000	0·029
$P_2 \times P_3$ (F_2 population)	92	0·245	0·00081	47·530	0·027

ances, heritability estimates and genetic advance (at 5% level of selection) are given in Table I.

The formula, $\frac{VF_2 - VE}{VF_2}$ was used for the calculation of heritability in broad sense wherein, VF_2 = variance of F_2 population and $VE = \frac{VP_1 + VP_2}{2}$. The non-fixable components of variation and the genotype environment interactions have not been removed from the F_2 variance. The data clearly indicate that in both the crosses studied, there is considerable evidence for additive and cumulative gene action for the DBC values (Fig. 1). This is expected, since very diverse parents have been crossed in either case. A large number of genes must be responsible for the determination of 'DBC' values since moderate heritability estimates have been obtained. It is, however, remarkable that the two estimates are almost alike. The genetic advance calculated[9] indicates that F_3 lines derived from the 5% top F_2 selections would be 0·03 units higher than the mean of F_2.

The heritability estimates in the present study compare fairly well with similar studies done in wheat, soybean and other crops.[10-12] With larger population at hand, it should be possible to breed for high DBC value which in turn would result in genetic advance for protein content and quality.

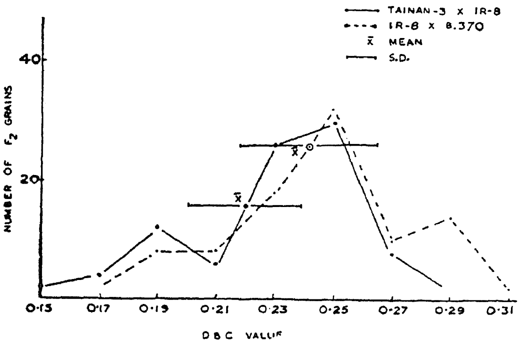


FIG. 1. Distribution of F_2 population of two crosses in rice for DBC value.

We are highly thankful to Dr. M. S. Swaminathan for his keen interest in the work and kindly going through the manuscript.

---

1. Juliano, B. O., Albano, E. L. and Cagampang, G. B., *Philippine Agriculturist*, 1964 **48**, 234.
2. Kaul. A. K., Dhar, R. D and Swaminathan, M. S., *Curr. Sci.*, 1969, **38** (22). 529.
3. Davis, W. H., Middleton. G. K. and Hebert, T. T., *Crop Sci.*, 1961, **1**, 235.
4. Haunold, A., Johnson, V. A. and Schmidt, J. W., *Agron. J.*, 1962 *a*, **54**, 121.
5. —, — and —, *Ibid.*, 1962 *b*, **54**, 203.
6. Johnson, V. A., Schmidt, J. W., Mattern, P. J. and Haunold, A., *Crop. Sci.*, 1963, **3**, 7.
7. Kaul, A. K., Dhar. R. D., Swaminathan. M. S. and Ahnstrom, G., *Curr. Sci.*, 1969, **14**, 330.
8. Mather, K., *Biometrical Genetics*, Dover Publication, Inc., U.S A., 1949.
9. Allard, R. W., John Wiley and Sons, Inc., New York, 1960.
10. Kaul, A. K. and Sosulski, F. W., *Canad. J. Genet. Cyt.*, 1965, **7**, 12.
11. Stuber, C. W., Johnson, V. A. and Schmidt, J. W., *Crop. Sci.*, 1962, **2**, 506.
12. Weber, C. R., *Research Bulletin*, Ames., Iowa, 1950, p. 767

RATE COEFFICIENT FOR TWO-BODY N-ATOMS RECOMBINATION

S. N. GHOSH AND S. K. JAIN

J.K. Institute of Applied Physics, Allahabad University, Allahabad

THE recombination of N-atoms is important in many phenomena. During discharge through nitrogen, N_2 molecules are excited, ionized and/or dissociated. The dissociated N-atoms afterwards recombine and produce active nitrogen. Again, in the upper atmosphere, N-atoms are produced by dissociation of N_2 molecules by solar ultraviolet rays.[1] On reacting with constituent particles of the atmosphere—atoms, molecules, ions and electrons—they produce certain upper atmospheric phenomena. Data for two-body recombination of N-atoms[1] recombination are not available. In this note, two-body recombination of N-atoms is studied photometrically by the flow method. By assuming the recombination of N-atoms at the walls of the experimental system (pyrex glass), the rate coefficient of N-atoms recombination is estimated at a pressure of 100 μ of Hg and at a temperature of 295° K.

Experimental arrangement is shown in Fig. 1. It consisted of a pyrex glass tube 115 cm. long, 2·5 cm. in diameter and having six side tubes, spaced equally along the tube and closed at the ends by quartz windows. Tank nitrogen was introduced into the tube through a Hoke needle valve. Pressures at the ends of the tube were measured with N.R.C. thermocouple gauges. N_2 was then activated by means of a discharge produced by a magnetron oscillator (Raytheon Microtherm, Model CMD-4) operating at a frequency of 2450 Mc/s. and giving a maximum power output of 100 watts. Active nitrogen glow was produced which filled up whole of the experimental tube. Through the side tubes the intensities of the afterglow were measured with a photomultiplier tube (RCA 1 P 21) and an ultrasensitive microammeter (RCA Model WV 4 B). High voltages to the photomultiplier tube were supplied by Baird Atomic Superstable Power Supply (Model 312 A). The observed intensities at the different side tubes are given in Table I.

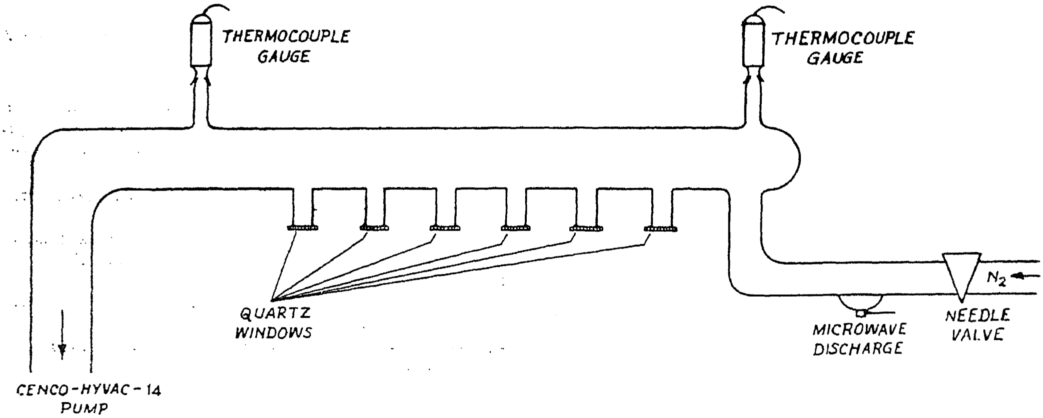


FIG. 1

As the N-atoms produced by the microwave discharge in N_2 move down the experimental tube, they recombine by the following processes:

1. Surface recombination
$$N + N + S \rightarrow N_2^* + S. \qquad (1)$$
2. Three-body recombination
$$N + N + M \rightarrow N_2^* + M. \qquad (2)$$
3. Two-body recombination
$$N + N \rightarrow N_2^*. \qquad (3)$$

Since the experiment was carried out at a pressure of 100 μ of Hg, the rate of loss of N-atoms due to the three-body recombination is very small and is therefore neglected.

Hence the rate of loss of N-atoms is given by

$$-\frac{dn}{dt} = K_s n + K_1 n^2 \qquad (4)$$

where

n—N-atoms concentration,

K_1—two-body rate coefficient for recombination of N-atoms,

K_s—surface recombination coefficient of N-atoms on pyrex glass and is given by:

$$K_s = \frac{S\bar{v}}{4V}\gamma \qquad (5)$$

where

S—surface area of the tube,

a—average velocity of nitrogen atoms,

γ—catalytic recombination efficiency of N-atoms at the glass surface,

$= 2 \times 10^{-5\,(2-4)}$

V—volume of the tube.

Integrating equation (4), we obtain

$$n = n_0 K_s \{e^{K_s t}(K_s + K_1 n_0) - K_1 n_0\}^{-1}. \qquad (6)$$

Since the pressure readings at the two ends of the reaction tube were almost the same, an essentially uniform distribution of atoms and molecules existed throughout the tube. At 100 μ pressure and 295° K, the number of nitrogen molecules is $3{\cdot}276 \times 10^{15}$ per cc and assuming 1·0% dissociation of N_2 molecules by the microwave discharge,* N-atoms concentration is $6{\cdot}55 \times 10^{13}$ per cc. Obtaining v at 295° K from kinetic theory

$$\bar{v} = \left(\frac{8KT}{m\pi}\right)^{\frac{1}{2}} \qquad (7)$$

and substituting values of other factors in the expression for K_s, one obtains $K_s = 0{\cdot}534$ sec.$^{-1}$

The gas was pumped from the reaction tube at the rate of $1{\cdot}29 \times 10^2$ cm.^{3}/sec. at 100 μ of Hg. Hence, 1 cm. distance along the experimental tube is covered in $3{\cdot}81 \times 10^{-3}$ sec. Utilizing this value the concentration of N-atoms at the different side tubes are then determined. The intensities at the side tubes are calculated from the relation

$$I = kn\,(K_s + K_1 n) \qquad (8)$$

and are given in the left column of the table. It is seen that the observed intensities agree well for $K_1 = 8 \times 10^{-13}$ cm.^{3} sec.$^{-1}$

From Table I it will be seen that the intensity at the first window is larger than what is expected. It may be mentioned that the intensity peak drifts down the experimental tube as the pressure is increased and may be due to traces of secondary afterglow, namely, 'Pink Afterglow'.[5] However, earlier workers reported that such afterglow is observed only when highly purified nitrogen is used.

TABLE I

No. of side tubes	Distance (cm.) from the region where discharge was initiated	Observed intensity* (in μA)	Calculated intensity in (μA)
1	20	1·80	1·06
2	30	0·80	0·85
3	40	0·63	0·69
4	50	0·52	0·58
5	60	0·48	0·48
6	70	0·44	0·42

* Corrected for dark current of the photomultiplier tube.

---

* The degree of dissociation varies mainly with the power of the oscillator which causes discharge. Its value ranges between 1-6%. As the power in the present case is low, the lowest value is assumed.

1. Herzberg, G. and Hergberg, L., *Nature*, 1950, **161**, 283.
2. Herron, J. T., Franklin, J. L., Bradt, P. and Dibeler, V. H., *J. Chem. Phys.*, 1959, **30**, 879.
3. Young, R. A., *Ibid.*, 1961, **34**, 1292.
4. Wentink, T. Jr., Sullivan, J. O. and Wray, K. L., *Ibid.*, 1958, **29**, 231.
5. Beale, G. E. and Broida, H. P., *Ibid.*, 1959, **31**, 1030.

THE MEGATECTONICS OF CONTINENTS AND OCEANS*

As a result of development of palaeomagnetism in the last two decades, and also of improved techniques for accurate measurements of this fossil record of geomagnetism in rock samples, there has arisen a revival of interest in the hypothesis of continental drift which remained almost a discarded subject in the forties. The recent findings of "Ocean floor spreading" have added interest to the subject of global tectonics.

The book under review is the outcome of lectures given at a symposium on matters relating to continental drift, at Rutgers University in the summer of 1966. There are 12 chapters in the book and each chapter gives a bibliography of references at the end. There are 81 figures and a useful index.

The fundamentals of palaeomagnetic methods are described by David Collinson. Tuzo Wilson and Robert Dietz each outlines aspects of the development of the theory of sea floor spreading and its many implications. Three regions of special interest in the continental drift theory are reviewed in the three chapters: "Crustal Deformation in the Western United States", by James Gilluly; "Tectonics and Geophysics of Eastern North America", by Philip B. King; and "The Mediterranean, Ophiolites, and Continental Drift", by John C. Maxwell. The chapter on "Developments in Seismology and Georheology" is contributed by Leon Knopoff. Adrian Scheidegger examines the large-scale tectonic stress field of the crust.

Aeromagnetic surveys used in exploration for petroleum also provide data for research in basement tectonics. James Affleck presents three results of such studies which bear on continental drift and polar wander. Paul Lyons contributes another basement tectonics study suggesting that large-scale crustal movements are confined to lateral displacements along faults.

Finally, in two recently invited papers for the book Kenneth S. Deffyes discusses a proposed model for the area of generation of new crust, and R. K. Olsson outlines the impact of palaeomagnetic dating and sea floor spreading on advances in biostratigraphy.

Thus the book provides a collective account of our present knowledge on global tectonics since the palaeomagnetic breakthrough in the mid-fifties.

---

* *The Megatectonics of Continents and Oceans.* Edited by Helgi Johnson and Bennett L. Smith. (Rutgers University Press, 30, College Avenue, New Brunswick, N.J. 08903), 1970. Pp. xii + 282. Price $ 12.50

LETTERS TO THE EDITOR

EINSTEIN COEFFICIENT OSCILLATOR STRENGTH AND THE LIFETIME MEASUREMENT IN THE B 1 – X $^1\Sigma$ SYSTEM OF PbO

RELATIVELY few of the important band systems observed in the spectra of cosmic bodies and also commonly found on earth have been fully or partly studied from an intensity point of view.

Knowledge of intensity gives a clear understanding of the transitions, and therefore the states and conditions of reactions responsible for excitation and its surroundings. The expression for the intensity of a v', v'' transition in emission is given as

$$I_{v' v''} = 64/3\, \pi^4 c\, N_{v'}\, \nu^4\, \overline{R_e^2}\, [\textstyle\int \psi_{v'} \psi_{v''}\, dr]^2$$

where c is the velocity of light, ν the frequency of the transition, $N_{v'}$ the population in the excited state, R_e is the electronic transition moment assumed to be independent of the internuclear distance, and the quantity $[\psi_{v'}\psi_{v''} dr]^2$ is the Franck-Condon factor.

The preceding equation can also be written as

$$I_{v' v''} = N_{v'}\, E^4_{v' v''}\, R_e^2\, (\bar{r}_{v' v''})\, q_{v' v''}$$

where E is the energy of the transition, $R_e^2\, (\bar{r}_{v'v''})$ is the electronic transition moment as a functiin of r-centroids and $q_{v'v''}$ is the Franck-Condon factor for the transition.

$$R_e^2\, (\bar{r}_{v' v''})\, q_{v' v''} = |\textstyle\int \psi_{v'}\, R_e(r)\, \psi_{v''}\, dr\,|^2 = S_{v' v''}$$

where $S_{v'v''}$ is called the band strength expressed in atomic units.

The expression relating the Einstein coefficient and the band strength is given by Penner[1] as;

$$A_{v' v''} = \frac{2 \cdot 026 \times 10^6\, S_{v' v''}}{g_u \lambda^3}\ \text{sec}^{-1}$$

where $A_{v'v''}$ is the Einstein coefficient, g_u is the statistical weight of the upper level and λ is the wavelength in microns.

Further expression relating the Einstein coefficient and the oscillator strength is given as

$$f_{v' v''} = 1 \cdot 5 \times 10^{-8}\, \lambda^2\, A_{v' v''}$$

where $f_{v'v''}$ is the oscillator strength, λ is the wavelength in microns and $A_{v'v''}$ is the Einstein coefficient in sec.$^{-1}$.

The band strength for the B1–X $^1\Sigma$ system of PbO has been determined by Dube *et al.*[2] exciting the PbO B1–X $^1\Sigma$ system in an arc. On the basis of the measurements of the band strengths, calculation of the Einstein coefficient, oscillator strength and lifetime is done. The results are tabulated in Table I. The lifetime of the zeroth vibrational level of the upper state is calculated to be $8 \cdot 526 \times 10^{-6}$ sec.

TABLE I

V′, V″	λ (A)	$S_{v'v''}$ $(a_0^2 e^2)$	$A_{v'v''}$ sec^{-1}	$f_{v'v''}$
0, 1	4658	13·5 – 4	13·54 + 3	4·407 – 5
0, 2	4817	28·7 – 4	26·0 + 3	9·048 – 5
0, 3	4984	40·7 – 4	33·3 + 3	12·405 – 5
0, 4	5162	36·3 – 4	26·74 + 3	10·689 – 5
0, 5	5353	26·8 – 4	17·60 + 3	7·605 – 5

N.B.: The numbers against the quantities with plus and minus signs are the powers of ten to be multiplied.

In some cases it has been possible to use lifetime measurements to place relative band strength on an absolute scale. The same method has been applied to aeronomic and non-aeronomic band systems.[3,4] Attempts have also been made to interpret band intensity measurements in terms of effective electronic oscillator strengths for the complete band system, although it is doubtful if the concept is meaningful to more than an order of magnitude.

Dept. of Spectroscopy, **PREM SHANKAR DUBE.**
Banaras Hindu University,
Varanasi-5, October 5, 1970.

---

1. Penner, S. S., *Quantitative Molecular Spectroscopy and Gas Emissivities*, John Wesley Publishing Co., Inc., U.S.A., 1959.
2. Dube, P. S., Upadhya, K. N. and Rai, D. K., *J. Quant. Spectros. Radiant. Transfer*, 1970 (In press).
3. Nicholls, R. W., *Laboratory Astrophysics and Combustion Spectroscopy*, ed. Penner, S. S., Pergamon Press, 1964.
4. —, *Cand. J. Phys.*, 1962, **40**, 1772.

SOLUTION PROPERTIES OF POLY (BUTYL ACRYLATE) AND POLY (BUTYL ACRYLATE-CO-STYRENE)

STUDIES on configurational and frictional properties of Poly (butyl acrylate) have not so far been carried out. We have investigated monodisperse Poly (butyl acrylate), PBA, in good solvent, methyl ethyl ketone, (MEK), at 35° C. and the effect of introducing styrene units in poly (butyl acrylate) on the solution properties by a study of poly (butyl acrylate-co-styrene) PBAS, in methyl ethyl ketone and toluene at 35° C.

EXPERIMENTAL

PBA was prepared by solution and bulk polymerization of butyl acrylate with azobisisobutyronitrile or benzoyl peroxide as initiators in various solvents at 35° C. and 60° C. in nitrogen atmosphere with restricted conversion, ca $< 15\%$. The purified polymer was fractionated into eight fractions with MEK as solvent and methanol-water (6 : 1 vol.) as a precipitant. Bulk co-polymerization of styrene and butyl acrylate was carried out with benzoyl peroxide as catalyst in nitrogen atmosphere at $60° \pm 0\cdot1°$ C. with restricted conversion, ca $< 5\%$ to yield PBAS in 1 : 1 composition and the purified co-polymer was fractionated (8 fractions) with MEK and methanol as solvent and non-solvent respectively. The composition and microstructure of co-polymer was determined by nuclear magnetic resonance.[1,2] The appearance of shoulder in the phenyl proton peak[3] at $3\cdot03\ \tau$ and the ratio of the area of phenyl proton peak to the $O{-}CH_2$ proton peak at $6\cdot03\ \tau$ being unity, indicated the absence of alternation but the proportion of the two units to be 1 : 1 as expected from kinetics.[4] The molecular weights of PBAS fractions in different solvents of varying refractive index increments were almost same, indicating the composition heterogeneity to be narrow. Intrinsic viscosities $[\eta]$ of the purified and fractionated samples of PBA and PBAS were measured in MEK and toluene respectively at 35° C. in the suspended level dilution viscometer (PCL, Colchester Instruments Ltd., U.K.), for $[\eta] < 300$ and in a variable shear rate viscometer for $[\eta] > 300$. The scattered light intensities were measured for the carefully centrifuged and filtered solutions at 45–135° angles in the light scattering photometer (Brice-Phoenix Universal 1,000 series; Phoenix Precision Instrument Company, Philadelphia) for incident unpolarized light $\lambda = 4356$ Å. The refractive index increments of polymer samples were also measured at the same wavelength in differential refractometer (Brice-Phoenix Instruments Company, Philadelphia). The light scattering data were processed using computer IBM 1,130 and results were treated according to Zimm[5] for the determination of weight average molecular weight and other parameters. The number average molecular weight $\bar{M}_n$ was determined with Osmometer (Pinner-Stabin; Colchester Instruments Ltd., U.K.).

RESULTS AND DISCUSSION

(*i*) From the intercepts of the plots of $\eta sp/c$ *vs.* c and $(ln\eta_{rel})/c$ *vs.* c, $[\eta] = 101\text{–}800$ ml. gm.$^{-1}$ for PBA in MEK at 35° C. for $\bar{M}_w = 0\cdot48\text{–}11\cdot37 \times 10^6$ and $[\eta] = 64$ to 179 ml. gm.$^{-1}$ for PBAS in MEK at 35° C. and $[\eta] = 78$ to 198 ml. gm.$^{-1}$ for PBAS in toluene at 35° C. for $\bar{M}_w = 2\text{–}7 \times 10^5$ were obtained. The Huggins' constant k' ranged from 0·33 to 0·35 for PBA in MEK and 0·30 to 0·37 and 0·28 to 0·38 in MEK and toluene respectively for PBAS.

(*ii*) From log $[\eta]$ *vs.* log $(\bar{M}_w)$ plots the following equations were obtained:

$[\eta] = 2\cdot41 \times 10^{-2}\,\bar{M}_w{}^{0\cdot64}$ for PBA in MEK at 35° C.

$[\eta] = 6\cdot85 \times 10^{-3}\,\bar{M}_w{}^{0\cdot75}$ for PBA in acetone at 25° C.

$[\eta] = 3\cdot09 \times 10^{-3}\,\bar{M}_w{}^{0\cdot81}$ for PBAS in MEK at 35° C.

$[\eta] = 1\cdot45 \times 10^{-2}\,\bar{M}_w{}^{0\cdot71}$ for PBAS in toluene at 35° C.

The low value of '*a*' (0·64) for PBA/MEK compared to PBA/acetone indicated that methyl ethyl ketone is a more ideal solvent than acetone. The lower value of '*a*' for PBAS/toluene than for PBAS/MEK indicated that toluene is more ideal than MEK. The high value of '*a*' for PBAS/MEK compared to PBA/MEK ($a = 0\cdot64$) and poly styrene ($a = 0\cdot62$) at 35° C. indicated the increased thermodynamic interaction between PBAS and MEK.

(*iii*) The molecular weight heterogeneity $\bar{M}_w/\bar{M}_n = 1\cdot25$ for PBA and PBAS was found.

(*iv*) The following relationships were established at 35° C.

$(\bar{r}^2)_w{}^{1/2} = 0\cdot98\,\bar{M}_w{}^{0\cdot52}$ for PBA in MEK.

$(\bar{r}^2)_w{}^{1/2} = 0\cdot43\,\bar{M}_w{}^{0\cdot56}$ for PBAS in MEK.

The higher value of the exponent for PBAS shows more thermodynamic interaction between PBAS + MEK than PBA + MEK.

(*v*) Relationship between second virial coefficient A_2 and $\bar{M}_w$ was established from log (A_2) *vs.* log $\bar{M}_w$.

$A_2 = 4\cdot35 \times 10^{-3}\,\bar{M}_w{}^{-0\cdot23}$ for PBA in MEK at 35° C.

(*vi*) Flory's constant K, for PBA and PBAS from $[\eta]$ and $\bar{M}_w$ data were obtained by various well-known methods.[6-9] All methods gave the same value of $K = 12 \cdot 54 \times 10^{-2}$ for PBA/MEK and PBAS/toluene $(11 \cdot 02 \times 10^{-2})$. Flory-Fox method was not applicable to PBAS/MEK since a negative intercept was obtained and all the other methods for this system also gave lower value of $K = 6 \cdot 0 \times 10^{-3}$. For poly (methyl acrylate) in methyl ethyl ketone, a similar observation was made.[10] It may be emphasized that method due to Flory-Fox and other methods give lower value for unperturbed dimension when the extension of the chain is large (indicated by the exponent in Mark-Howink equation $a = 0 \cdot 8$).

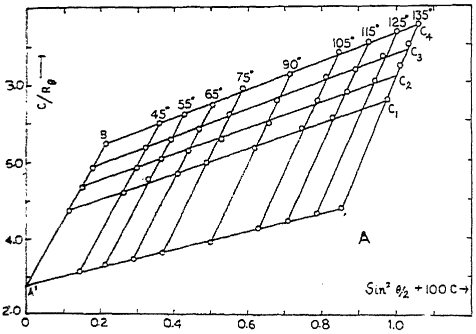


FIGURE 1 —ZIMM PLOT

$C_1 . C_2 . C_3 . C_4$ CONCENTRATION OF POLYMER SOLUTION IN gm.ml^{-1}×100

$A'A = (C/R_\theta)_{C=0}$ vs $\sin^2 \theta/2$ $A'B = (C/R_\theta)_{\theta=0}$ vs 100 C

R_θ = REDUCED INTENSITY AT ANGLE θ

FIG. 1

(*vii*) $(\bar{r}_0^2)^{\frac{1}{2}}$ unperturbed end to end distance for PBA (782 Å to 3545 Å) and PBAS (429 Å to 595 Å) by Stockmayer-Fixman-Bauman[11] method and the linear expansion factor α (1·07 to 1·17) for PBA/MEK and (1·16 to 1·28) for PBAS/MEK were obtained. The expansion parameter and unperturbed root mean square radius of gyration increase with molecular weight as expected.

(*viii*) The Flory's universal parameter $\phi = < [\eta] \ \bar{M}_w / (\bar{r}^2)_w^{3/2} >$ for PBA was found to be $1 \cdot 0 \times 10^{23}$ which is slightly lower than the ideal value $(2 \cdot 87 \times 10^{23})$ for flexible chain polymers but compares well with that calculated from reported[12,13] values for acrylate polymers. $\phi = (2 \cdot 78 \times 10^{23})$ for PBAS/MEK is in excellent agreement with expected value.

(*ix*) The orders of magnitude for extensions of polymeric chain due to long range and steric effects $[(\bar{r}^2)_w^{\frac{1}{2}} / (\bar{r}_f^2)^{\frac{1}{2}}]$ being 4·48 to 4·92 for PBA/MEK and 4·08 to 4·32 for PBAS/MEK and values for the extension due to steric effects alone $(\bar{r}_0^2)^{\frac{1}{2}}/(\bar{r}_f^2)^{\frac{1}{2}}$ being 4·18 for PBA and 3·45 for PBAS were evaluated. The value for PBA is greater than that (3·61) for poly (methyl acrylate).[12]

(*x*) From the slopes of the plots of $(\bar{r}_0^2)^{\frac{1}{2}}$ *vs.* $(2 \text{ DP})^{\frac{1}{2}}$ (DP = degree of polymerization) the value of the length of the statistical chain element, $b = 9 \cdot 09$ Å for PBA and 5·48 Å for PBAS were obtained.

Dept. of Physical Chem., K. S. V. SRINIVASAN.
Univ. of Madras, K. KARUNAKARAN.
Madras-25, M. SANTAPPA.
October 6, 1970.

---

1. Bovey, F. A., Tiers, G. V. D. and Fillipovich, G., *J. Polymer. Sci.*, 1959, **38**, 73.
2. —, *Ibid.*, 1962, **62**, 197.
3. Ito, K. and Yamashita, Y., *Ibid.*, 1965, **3B**. 625.
4. Bradbury, J. H. and Melville, H. W., *Proc. Roy. Soc.* (London), 1954, **222 A**, 456.
5. Zimm, B. H., *J. Chem. Phys.*, 1948, **16**, 1093, 1099.
6. Plory, P. J., and Fox, T. G Jr., *J. Amer. Chem. Soc.*, 1951, **73**, 1904.
7. Kurata, M. and Stockmayer, W. H., *Forts Chr. Hockpolym. Forshe*, 1963, **3**, 196.
8. Stockmayer, W. H. and Fixman, M., *J. Polym. Sci.*, 1963, **1 C**, 137.
9. Hiroshi Inagaki, Hidematsu Suzuki and Michio Kurata, *Ibid.*, 1966, **409 C**, 425.
10. Krause, S., *Dilute Solution Properties of Acrylic and Methacrylic Polymers*, *Part* 1, *Revision* 1, Rohm & Haas Co., Philadelphia, Pennsylvania, Feb. 1961.
11. Bauman, H., *J. Polym. Sci.* 1965, **3B**, 1069.
12. Karunakaran, K., *Ph.D. Thesis*, University of Madras, January 1967.
13. Kotera, A. Saito, I., Watanabe, Y. and Ohama, M., *Makromol Chem.*, 1965, **87**, 195.

STRUCTURE OF IXIOLITE

THE structure of ixiolite, a naturally-occurring mineral essentially a tantalate of manganese, has not been sufficiently studied. Tavora[1] took the X-ray photograph of the sample, but it was not indexed and the system was not known. Reference[2] shows it to be tetragonal. We have synthesised the sample $(MnTa_2O_6)$ and made a structural study.

The sample was prepared by mixing appropriate proportions of MnO and Ta_2O_5 and firing the mixture at 1,100° C. for 20 hours, and at 1,350° C. for five hours in air. Finally, the sample was quenched to room temperature. The powder thus obtained was passed through a 300 mesh and the diffractometer pattern was taken using Mo $K\alpha$ radiation filtered through Zr foil. The diffractometer was operated at 30 K. watts and 15 amps. and was driven at the rate of 1° per minute. The chart thus obtained was used to calculate the lattice dimensions.

The X-ray data is given in Table I. We indexed the pattern on the basis of orthorhombic symmetry, with the following lattice dimensions:

$$a = 5\cdot910\ \text{Å},\ b = 14\cdot95\ \text{Å},\ c = 5\cdot09\ \text{Å}.$$

TABLE I

d Å	I/I_0	*hkl*	d Å	I/I_0	*hkl*
4·722	10	120	1·780	10	081
3·841	70	040, 111	1·760	10	180
3·575	10	031	1·654	40	252, 023
3·135	100	131	1·643	40	350
2·616	20	220	1·628	10	033
2·550	10	060	1·554	10	360
2·430	60	102	1·478	20	053
2·128	15	250	1·467	10	332
1·986	20	300	1·437	10	420
1·930	20	202	1·373	10	440
1·788	30	232			

We observed that ixiolite is isostructural with tapiolite, which was also indexed[3] on the basis of orthorhombic symmetry. Hence, it is reasonable to assume the structure of ixiolite as each metal atom is surrounded by a nearly regular octahedron of oxygen atoms. The distribution of MO_6 octahedra is such that the oxygen atoms are themselves close-packed. The TaO_6 octahedra are linked together in chains ranging along a_0 axis and held together by sharing edges while the adjacent chains of octahedra share corners.

Dept. of Inorganic and
Structural Chemistry,
Institute of Science,
Nagpur, India,
October 12, 1970.

D. A. BRAGANZA.
K. M. PHADKE.
A. M. WADITWAR.
S. P. KEDAR.
K. RAMA RAO.

---

1. Tavora, *Anais. Acad. Brasileira ciene*, 1955, **27**, 18.
2. Dana, E. S., *Text-Book of Mineralogy*, 1966 Edition, p. 697.
3. Rama Rao, K. and Deshpande, V. V., *J. Ind. Chem. Soc.*, 1969, **46**, 1051.

RELATIVE EFFICIENCY OF BACTERIAL GUM AND ORGANIC MATTER EXTRACT AS AGGREGATING AGENTS IN SAND-CLAY MIXTURES

IT is well known that organic matter and bacterial gums are the main agents that bind the fundamental soil particles, namely, clay, silt and sand. Depending on the binding action between the particles, aggregates of different sizes are formed. The relative efficiency of organic matter and bacterial gum as aggregating agents has, however, not been clear although a few aggregate models based on the possible distribution of these materials in soils have been suggested.[1] Moreover, determination of aggregate stability by Yoder's technique requires the aggregates to move in columns of sieves immersed in water, while under field conditions, the soil solution moves through porous beds, the rate of its movement being a function of the pore size and the stability of the aggregates.

In the present investigation, binding strength of organic extract from partly-decomposed leaf material is compared with that of bacterial gum (*Rhizobium meliloti*) using the technique of displacement of liquid through porous beds developed in this laboratory.[2] The relative effectiveness of organic matter and microbial gum as binding materials is discussed.

Clay fraction separated from a black soil mostly containing montmorillonite was mixed in different proportions with cleaned and dried river sand. The mixtures were filled in glass tubes of 14 mm. diameter and 15 cm. length. It was observed that mixtures containing 20% and greater amounts of clay rapidly dispersed, blocking the flow completely, when liquid was made to flow through the tubes kept horizontally. This limiting proportion of mixture was used for aggregation with three aggregating agents, namely, bacterial gum mixed at the rate of 18·75 mg. total solids per kg. mixture, organic matter extract obtained from 7·5 gm. of leaf compost and a combination of bacterial gum and organic matter in half the proportions mentioned above. The bacterial gum (*Rhizobium meliloti*) and dilute sodium hydroxide extract from partially decomposed leaf materials were dialysed free of salt before adding to the sand-clay mixtures. Aggregates passing through a 2 mm. sieve were filled in the glass tubes and the pattern of displacement of N/20 calcium chloride held in the pores of the tube by N/20 calcium nitrate was investigated. The rate of flow was calculated from the volume of the liquid collected at the open end and the average effective cross-section of the porous column, determined from the volume of calcium chloride solution held by the column.

The flow rates obtained in replicates are recorded in Table I. It may be seen from the results that the flow rate was lowest with the aggregates bound by the bacterial gum. This is perhaps due to the small size of aggregates formed with bacterial gums. The organic matter extract and the mixture of organic matter and bacterial gum appear to bind the clay and sand particles into comparatively larger-sized aggregates giving higher rates of flow.

The stability of the aggregates obtained was studied by repeating the displacement after resaturating the porous column with N/20 calcium chloride solution. The rate of flow calculated in each successive run is recorded in Table II.

TABLE I

Flow rates observed with the 20% clay-80% sand mixture with different aggregating agents

Aggregating agent	Amount of aggregating agent used per kilogram mixture	Rate of flow cm /sec.*
Bacterial gum ..	18·75 mg. total solids	(*a*) 0·019 (*b*) 0·017
Organic matter extract	Corresponding to 7·5 gm. compost	(*a*) 0·023 (*b*) 0·024
Bacterial gum + organic matter extract	9·4 mg. bacterial solids + extract from 3·75 gm. compost	(*a*) 0·025 (*b*) 0·026

* (*a*) and (*b*) are values obtained in replicates.

TABLE II

Flow rates with repeated runs on the columns of aggregates bound with different agents

Aggregating agent	Number of run	Flow rate cm./sec.
Bacterial gum ..	1	0·019
	2	0·018
	3	0·017
Organic matter extract ..	1	0·023
	2	0·016
	3	0·017
Bacterial gum + organic matter extract	1	0·025
	2	0·012

In the case of the mixture of bacterial gum and organic matter, even at the second run the rate of flow had considerably decreased. As such a third run was not attempted. Results recorded in Table II clearly indicate that in the case of bacterial gum, the flow rate for the three repeated runs is almost constant. In the case of organic matter extract, the flow rate was higher than in the aggregates with bacterial gum but there was a sudden decrease in the second run indicating a possible breakdown of bigger soil aggregates. This is further confirmed by the collapsing flow rate in the second run with the aggregates formed with a combination of both the binding agents. Probably, the organic matter gets washed out resulting in the collapse of the structure.

Organic matter that spreads as a thin film on the sand particles as proposed by Emerson[1] may assist in the formation of bigger but unstable aggregates while bacterial gums by their thread-like structure bind the clay particles into smaller but stabler aggregates. Legume nodule bacteria thus seem to play an important role in the building of soil structure. This is borne out by the results obtained in several field experiments where legumes are grown in crop rotation.[3] The senior author is grateful to the FAO/IAEA, Division of Atomic Energy in Agriculture, for the award of a Fellowship during the course of the investigation.

Division of Agric. Physics, V. A. K. SARMA.
Indian Agric. Res. Inst., C. DAKSHINAMURTI.
New Delhi, India,
October 20, 1970.

---

1. Emerson, W. W., *J. Soil Sci.*, 1959, **10**, 227.
2. Daksninamurti, C. and Mansharamani, N., *Technical Reports Series*, IAEA, Vienna. 1966, **65**, **46**.
3. Prabhakara, J., *M.Sc. Thesis*, I. A.R.I., New Delhi, 1970.

STRUCTURE OF SALACIA DIKETONE - A FROM *SALACIA PRENOIDES*

FROM the root bark of *Salacia prenoides* D.C. Heymann *et al.*[1] isolated two substances $C_{30}H_{48}O_3$ and $C_{30}H_{46}O_3$ both having the -CO-CH$_2$-CO- grouping. We have re-examined this plant material and obtained, besides the above two, another compound $C_{30}H_{48}O_2$ which we name Salacia Diketone-A whose UV and IR spectra reveal that it also has the -CO-CH$_2$-CO- grouping. In its mass spectral fragmentation, it was very similar to friedelin indicating the possibility of its being related to friedelin. Since there is only one ring, namely A, in friedelane which can accommodate the -CO-CH$_2$-CO- grouping, the substance could be friedelane-1, 3-dione. This compound has now been synthesised starting from friedelin *via* its Δ^2-enol benzoate. The natural and synthetic compounds have been found to be completely identical in all respects including IR spectra.

While processing large quantities of the plant material, we found that it also contains an extremely small proportion of friedelin itself. The co-occurrence of a monoketone and a diketone of friedelane is interesting.

The authors thank Professor T. R. Seshadri for his kind interest and the Indian Council of Medical Research for a research fellowship to one of us (N. C. T.).

Dept. of Chemistry, S. RANGASWAMI.
Delhi University, N. C. TEWARI.
Delhi-7, *September* 28, 1970.

---

1. Heymann, H., Bhatanagar, S. S. and Fieser, L. F. *J. Amer. Chem. Soc.*, **1954**, **76**, 3689.

PSEUDOMORPHOUS CALCITE CUBES FROM KOYANANAGAR, MAHARASHTRA, INDIA

DURING their visits to Koyananagar (17° 24′ N.; 73° 45′ E.) immediately after the severe earthquake of 11th December 1967, the authors came across some excellent specimens of calcite showing an almost perfect cubic form. These occur in druse cavities in basalts and are associated with stilbite. The calcite cubes are colourless, transparent, and almost uniform in size with edges measuring about 1 cm. Goniometric measurements of interfacial angles showed an exact value of 90°. Interpenetration twins are quite common. Microscopic examination clearly reveals that the mineral under study is calcite showing uniaxial negative interference figure, and refractive indices measuring $n_\epsilon = 1\cdot486$ and $n_\omega = 1\cdot658$. It is apparent that the calcite, in this case, is pseudomorphous after some mineral belonging to cubic system. None of the druse minerals in basalts of the Deccan, save analcime, have a cubic symmetry. Analcime shows a trapezohedral form and thus the morphology of calcite under reference does not fit this mineral. The occupants of the druse cavities in basalts are generally low temperature minerals, and the development of the cube (1 0 0) form of the original mineral represented by calcite is consistent with this. The interpenetration twins noted here are of common occurrence in the mineral fluorspar.

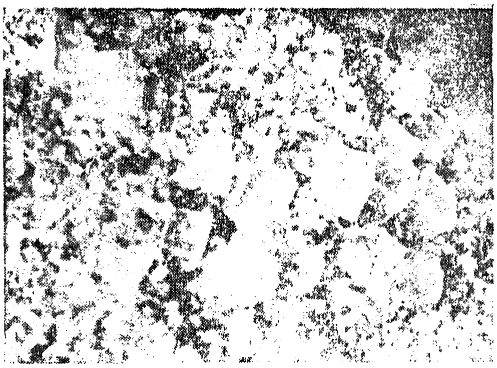


FIG. 1. Pseudomorphous calcite cubes from Koyana nagar.

The cube form of calcite is here believed to be due to the replacement of fluorspar which had earlier crystallised from late stage magmatic emanations and had deposited in cavities. In this connection it may be stated that Subramaniam and Parimoo (1963) have attributed the genesis of fluorspar deposits of Amba Dongar, directly to the Deccan volcanism of India, and have believed that the mineralising solutions were given out by the basaltic magma during the fumarolic stage. Crystallisation of fluorspar in the druses in basalts of Koyananagar before being replaced by calcite could thus be possible.

The authors express their grateful thanks to Dr. K. B. Powar for critically going through the manuscript.

Dept. of Geology,
University of Poona,
Poona, *October* 12, 1970.

V. V. PESHWA.
ANANT V. PHADKE.

---

1. Subrahmaniam, A. P. and Parimoo, M. L., "Fluorspar mineralisation related to Deccan Basalt Volcanism at Amba Dongar, Baroda District, India," *Nature*, 1963, **198**, 563.

PLEISTOCENE DEPOSIT AROUND ARIYALUR (MADRAS)

THE area around Ariyalur is well known for its Cretaceous invertebrate fossils, while Dinosaurus bones have also been described from this region. Except for a note by Matley (1929, p. 346) in which he refers to certain mammalian remains, no other forms have been reported from the area. A collection made by this Department in 1952 contains, among other remains, a tooth of *Equus* (No. T/65) which has been recently identified by the author during the course of rechecking the Ariyalur materials. The specimen is well preserved except for the parastylid, external margin and part of the root.

The tooth is long (18 mm.), narrow (9 mm.) and hypsodont (55 mm.) and is posteriorly concave showing the characters of a last lower right molar. The valley between the metaconid and metastylid is U-shaped which is a caballine rather than a zebrine character. This leads to the conclusion that the molar may belong to *Equus namadicus* rather than to *Equus sivalensis*.

Pilgrim (1929, p. 346) identified the mammalian remains collected from this area by Matley as *Equus* and *Bos* (or *Buffelus*) and thought that these materials had been derived from the Cuddalore sandstone (Pliocene), whereas the present find indicates that there are some isolated patch of Pleistocene in the area since, according to him (1939 and 1944) *Equus sivalensis* lived during Pliocene and *Equus namadicus* during Pleistocene. Further, the matrix of the present specimen is the same earthly, calcareous, as that of the Cretaceous invertebrate fossils of Ariyalur, whereas the

TABLE I

The effects of boseimycin on growth and metabolism of glucose and lactic acid production and also change of pH in Bacillus subtilis *cultures*

Period of incubation in hours	Cell weight mg/10 ml			Glucose mg/ml			Lactic acid mg/10 ml			pH		
	Cont.	Bsm.	Stm.	Cont.	Bsm.	Stm.	Cont.	Bsm.	Stm.	Cont	Bsm.	Stm.
0	0·00	0·00	0·00	10·00	10·00	10·00	0·00	0·00	0·00	7·1	7·1	7·1
21	1·85	0·28	0·46	9·38	9·82	9·68	0·56	0·28	0·34	7·4	6·9	6·8
45	8·62	0·85	2·04	5·60	9·53	9·14	0·85	0·38	0·46	7·6	6·8	7·0
69	11·38	2·46	3·67	2·31	9·36	9·12	1·01	0·48	0·59	8·1	7·3	7·6
93	22·62	6·02	9·51	0·51	6·18	5·32	1·17	0·82	0·87	8·6	7·8	7·9
117	20·13	8·18	12·16	0·34	2·02	1·61	0·28	0·94	0·98	9·1	8·1	8·6

Cont. Control, Bsm. Boseimycin-treated (0·3 μg/ml), Stm.—Streptomycin (1·0 μg/ml) treated.

TABLE II

The effects of boseimycin on the metabolism of nitrogen and phosphorus in Bacillus subtilis *cultures*

Period of incubation in hours	Total nitrogen mg/10 ml			Total phosphorus mg/10 ml			Inorganic phosphorus mg/10 m.		
	Cont.	Bsm.	Stm.	Cont.	Bsm.	Stm.	Cont.	Bsm.	Stm.
0	5·08	5·08	5·08	4·00	4·00	4·00	4·00	4·00	4·00
21	4·65	4·96	4·88	3·86	3·86	3·78	2·25	3·62	2·98
45	4·01	4·78	4·62	1·84	3·21	3·01	1·68	2·95	2·55
69	3·65	4·70	4·52	1·71	3·03	2·83	1·62	2·71	2·48
93	2·35	4·25	3·83	1·63	2·71	2·41	1·61	2·44	2·07
117	2·64	4·01	3·60	1·98	2·19	1·79	1·62	1·82	1·50

Cont. Control, Bsm. Boseimycin (0·3 μg/ml) treated, Stm.—Streptomycin (1·0 μg/ml) treated.

69-93 hours of growth and subsequently lactic acid in the broth diminished probably due to its utilization owing to low availability of glucose. In antibiotic-treated cultures, lactic acid production increased steadily. Utilization of phosphate was comparatively higher during initial growth phase in control experiment but in broth boseimycin and streptomycin-treated cultures, phosphate utilization was comparatively higher towards the initial and later growth phase. The rate of utilization of nitrogen was directly linked with the growth of both antibiotic-treated and untreated cultures. So, from the present studies on the metabolism of *B. subtilis*, no specificity of boseimycin action can be suggested, rather the antibiotic exhibits essentially similar effects as induced by streptomycin.[6] Further studies with boseimycin revealed that protein was one of the macromolecules first inhibited followed by inhibition of DNA and RNA syntheses in *B. subtilis*.[7]

The author is grateful to Prof. P. N. Nandi, Head of the Department of Microbiology, for his interest in this work.

Dept. of Microbiology, TAPAN KUMAR MISRA.
Bose Institute, Calcutta-9,
April 19, 1971.

---

1. Sinha, R. K. and Nandi, P. N., *Experimentia*, 1968, **24**, 795.
2. —, *J. Antibiot.*, Japan, 1970, **23**, 360.
3. Folin, O. and Wu, H., *J. Biol. Chem.*, 1920, **41**, 367.
4. Barker, S. B. and Summerson, W. H., *Ibid.*, 1941 **138**, 535.
5. Hertha, H. T. and Ephriam, S., *Ibid.*, 1953, **302**, 675.
6. Mandal, A. and Majumdar, S. K., *Indian J. Biochem.*, 1966, **3**, 242.
7. Misra, T. K. and Sinha, R. K., *Experimentia*, (In press).

COMPOSITE CULTURES OF *RHIZOBIUM*—A BETTER MEANS OF INCREASING THE YIELDS OF SOYBEANS

SINGLE strain cultures of rhizobia are being used as inoculants for legume cultivation in India although U.S.A., Australia and other countries have resorted to multiple strain cultures and established the efficacy of such a procedure. However, ineffective strains have to be excluded from such composite cultures because they mitigate the ability of effective strains to establish in the root region.[1]

In order to try the performance of composite cultures, two strains of *R. japonicum* (SB-1

TABLE I

Soybean field experiment, Kharif, 1970*

(Average bean yield in kg per hectare ; var. Bragg in all places except at Junagadh where J–231 was used)

Treatments		Pantnagar (Foot hill swampy soil)	Jabalpur (Shallow black soil)	Kalyani (New alluvial soil)	Amravati (Medium black soil)	Junagadh (Medium black soil)	Ludhiana (Brown soil of Indus)
1. Control	..	2307	1639	1997	2040	573	1897
2. SB-1	..	2635	2839	2804	2250	2039	2534
3. SB-16	..	2637	2920	2561	2750	1924	2532
4. I.A.S.C.-2†	..	2644	3090	3147	2680	2091	2592
C.D. at 5%	..	326	348	843	443	424	523

* Trials at Delhi, Katrain, Berhampur and Coimbatore were not significant. † Composite culture of SB-1 and SB-16.

and SB-16) were chosen. They were shown earlier in this laboratory to be effective[2] and non-competitive in pot trials using soybean var. Bragg. They were also serologically homologous (personal communication from Dr. B. E. Caldwell, USDA). Ten different locations in India representing varied agroclimatic conditions were selected and field trials conducted under the All-India Co-ordinated Research Project on Soybean in *Kharif*, 1970.

Significant increase in the yield of beans due to inoculation with the composite culture (I.A.S.C.-2) was obtained at Pantnagar, Jabalpur, Kalyani, Amravati, Junagadh and Ludhiana (Table I). A noteworthy feature was that while SB-1 and SB-16 strains were not effective at Amravati and Kalyani respectively, the composite culture was significantly effective in increasing yields of soybean at both the places indicating the efficiency of composite cultures in different agroclimatic conditions. The usefulness of increasing the number of strains in preparing a composite rhizobial inoculum to suit different cultivars of soybean and soil conditions remains to be explored.

The author thanks Dr. N. S. Subba Rao, Head, Division of Microbiology, I.A.R.I., for critically going through the manuscript and Shri H. B. Singh, Co-ordinator, Soybean Scheme, for giving facilities to conduct this trial at various centres.

Division of Microbiol., V. R. BALASUNDARAM.
Indian Agric. Res. Institute,
New Delhi-12, *April* 3, 1971.

---

1. Burton, J. C., *Abst. X Intern. Cong. Microbiol.*, Mexico, 1970, p. 221.
2. Balasundaram, V. R., Iswaran, V.. and Sundara Rao, W. V. B., *Curr. Sci.*, 1970, **39**, 328.

OCCURRENCE OF WILT AND STEMBURN DISEASE OF *TEPHROSIA VOGELII* HOOK. F. IN INDIA

Tephrosia vogelii Hook. f., a tropical shrub, has been recently introduced in India from Puerto Rico and other places for its valuable rotenone. Rotenone is commonly used as insecticide to control certain household pests in storage and other insects in the field. During the year 1968-69, it was found that some of the plants of *T. vogelii* grown in experimental plots at Regional Research Laboratory, Jammu, showed wilted and stemburn symptoms. Experiments were, therefore, undertaken to study the causal agent and the results obtained are reported here.

Wilted plants showing typical stemburn symptoms were collected from the field and washed in water. The collar regions showing the symptoms were cut into small bits, surface-sterilised, washed again and were finally transferred to the tubes containing potato dextrose agar (PDA).

Out of 50 different isolates made a majority of them were *Pythium* spp. and the rest were *Fusarium* spp. Experiments were undertaken to study the pathogenicity of these two groups of fungal isolates by two different methods. In one set of experiments, cultures of the two fungi grown on PDA were mixed separately to the sterilized soil. The soil mixture thus obtained was filled into ten earthen clay pots for both the species of fungi separately. Two seedlings of *T. vogelii* of 80–90 days age were planted in each pot and were irrigated regularly once a day. Similar seedlings planted in 10 similar pots containing only sterilized soil without mixing the inoculum were kept as control. In the other set of experiment, the culture suspension of both the fungi was placed around the collar region of two plants of each pot. Ten pots containing two seedlings each were inoculated for *Fusarium* sp. and *Pythium* sp. separately and an equal number of seedlings without adding culture suspension served as control. Experiment was repeated three times. During all the three times, 80% to 90% of plants inoculated with the culture of *Pythium* sp. developed typical stemburn symptoms and started wilting within 15-20 days following inoculation. Whereas, all the plants inoculated with culture of the *Fusarium* sp. and also the plants maintained as control remained healthy and none of them exhibited any disease symptoms, indicating thereby the *Pythium* sp. as the causal agent involved in the stemburn disease of *T. vogelii*. The culture of the *Pythium* sp. was reisolated from the wilted plants and on identification the fungus involved was found to be *Pythium delense* Meura. Ruppel *et al*. earlier reported[1,2] *Rhizoctonia* sp. causing damping off and foliar blight in *T. vogelii* and the wilt disease by the *Phytophthora* sp.[3] *Pellicularia filamentosa* has also been reported to cause wilt both in *T. vogelii* and *Cajanus indicus*.[4] So far, *Pythium delense* Meura is known to cause stemburn and wilt in Delhi tobacco[5] and it has not been reported earlier to cause stemburn and wilt in *T. vogelii*. This is thus the first record of it.

The authors are indebted to the Director, Commonwealth Mycological Institute, Kew, for the identification of the fungus, and to Dr. K. Ganapathi, Director, Regional Research Laboratory, Jammu, for the facilities provided for the studies.

Regional Res. Lab.,
Jammu, *April* 20, 1971.

V. R. PANDOTRA.
*J. H. GUPTA.
**K. S. M. SASTRY.

Present Address : * Assistant Plant Pathologist, Govt. Paddy Research Station, Majhera, P.O. Garampani, Dist. Nainital (U.P.).

** Virus Pathologist, Institute of Horticultural Research, 255, Upper Palace Orchards, Bangalore-6.

1. Ruppel, E. G., Barner, D. K., Preyre, R. H. and Alma Santiago, *Plant Dis. Reptr.*, 1964, **48**, 714.
2. —, — and Alma Santiago, *Phytopathology*, 1965, **55**, 612.
3. —. and Alma Santiago, *Plant Dis. Reptr.*, 1965, **49**, 676.
4. Theis, T., Pregre, R. H and Kennard, W. C., *F.A.O. Plant Protec. Bull.*, 1957, **5**, 159.
5. Meura, A., *Phytopath. Zietschr.*, 1934, **7**, 169.

XYLARIA APICULATA COOKE, NEW TO INDIA

THIS fungus, described below, has not been reported in any of the previous lists of fungal flora of India and hence it is a new addition.

Xylaria apiculata Cooke.—Stroma usually gregarious, clavate, pulvinate to cylindrical or coniform with short acuminate sterile apex, stipe distinct short to elongate, black or dull brown, longitudinally channelled. Subiculum rough, dense matted to sparse, setose dull brown ropy, hyphae 4-6 µ in diameter. Initial layer of clava cream colour, later ectostroma turns yellow-gold, bulf, fawa or often feebly persistent. Surface of stroma wrinkled or smooth, perithecia completely immersed, globose to oval, 400-1000 µ × 500-1100 µ in size, ostiolate and medium papillate. Asci cylindrical, 80-150 µ × 9-12 µ, eight-spored. Ascospores gibbous to navicolor, narrow-ended, medium to dark brown with prominent sheath measuring 6-8 µ × 16-24 µ.

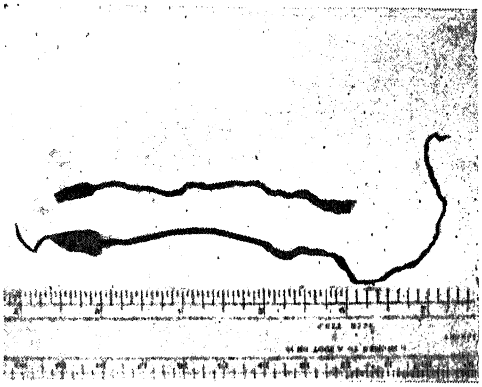


FIG. 1. Photograph of *Xylaria apiculata*.

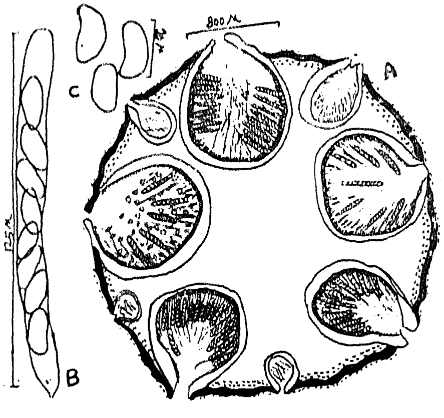


FIG. 2. A. T.S. of stroma showing perithecia and asci. B. Ascus with ascospores. C. Ascospores.

A collection of *Xylaria apiculata* Cooke was made from Bilasi, District Sangli, Maharashtra, in the month of September 1970.

Material of the fungus is deposited in the Mycological Herbarium of the Botany Department, Shivaji University, Kolhapur, Maharashtra, India.

Botany Department, A. N. THITE.
Shivaji University, U. K. KULKARNI.
Kolhapur-4,
(Maharashtra State), *February* 3, 1971.

---

1. Cooke, M. C., *Grevillea*, 1879, **8**, 60.
2. Martin, P., *Jour. of South African Botany*, 1967, **33**, 315.
3. —, *Ibid.*, 1967, **36**, 73.
4. Saccardo, P. A., *Sylloge Fungorum*, 1888, **1**, 309.

AN UNDESCRIBED SPECIES OF *PHYLLOSTICTA* FROM MAHARASHTRA

Bignonia unguis-cati L. (Fam. Bignoniaceae), popularly known as "Cat's-claw" is a beautiful tendril climber which clings to stone-walls through its typical small curved hook-like claws. Profuse bright yellow flowers produced in pendent bunches are used for decorative purposes. During the rainy season of 1970 (June-Sept.), a severe foliage disease was observed by the writers on this climber at Poona, characterised by numerous oval, ashy-white to pale-brown, leathery spots mostly originating from tips or margins. In advanced stage, such spots gradually enlarge and coalesce resulting in large irregular necrotic patches and bring about blighting. At this stage, these spotted areas show profuse growth of erumpent, dark, pinhead-like fruit bodies (pycnidia) of a species of *Phyllosticta* Pers. ex Desm., hitherto uninvestigated.

TABLE I

Comparison of species of Phyllosticta *reported on* Bignonia *species*

Fungus	Host	Pycnidia in μ	Pycnidiospores in μ	Authority
Phyllosticta tweediana Penz. et Sacc.	*Bignonia tweediana*	120–130 diam.	3–5·4×1·7–2	Saccardo (1884)
Phyllosticta sp. (under study) ..	*Bignonia unguis-cati*	68–170×60–100	6–10×3–4·5	Authors

Identity of the Fungus.—There is no report of any species of *Phyllosticta* on this host so far, except the one, *viz.*, *Phyllosticta tweediana*, reported on *Bignonia tweediana* Lindl. from Italy,[1] the comparison of which is given in Table I.

It is evident from Table I that the fungus under study is distinct in morphology in having much bigger pycnidia and pycnidiospores, thus justifying its accommodation as a new species with the following Latin diagnosis.

Phyllosticta bignonicola SP. NOV.

Infectionis maculae, epiphyllae, circulares vel irregulares, brunneae, dispersae. Pycnidia suberumpentia, spherical vel globoidea, fusce-brunneae vel nigra, in epiphyllo evoluta, ostolata, 68–170 × 60–100 μ; ostiole magnit 10–32 μ in diam. Pycnidiosporae unicellularia, hyalina, ovoid vel cylindrici, 6–10 × 3–4·5 μ.

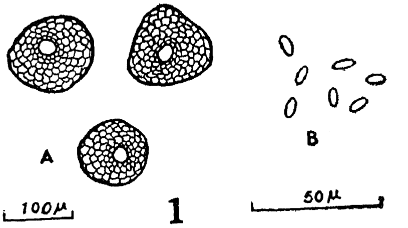


FIG. 1. *Phyllosticta bignonicola*. A, Pycnidia; B, Pycnidiospores.

In foliis vivtentibus *Bignonia unguis-cati* L. Leg. R.T.S. (15-6-1970) ad Poona (India), M.A.C.S. Mycol Herb. Sub-Numero 1208 (Typus).

The type material is being deposited in Herb. Orientalis, New Delhi, India, and C.M.I., Kew, England.

Grateful thanks are due to Prof. M. N. Kamat for his keen interest and advice, and to the Director for laboratory facilities.

Dept. of Mycology & V. G. RAO.
Plant Pathology, R. T. SOLANKURE.
M.A.C.S. Research Institute,
Poona-4, *March* 17, 1971.

---

1. Saccardo, P. A., *Sylloge Fungorum*, 1884, **3**, 28.

APOMIXIS IN *CENCHRUS CILIARIS*: A PRELIMINARY STUDY

THE genus *Cenchrus* has two important species, *viz.*, *C. ciliaris* and *C. setigerus*. In *C. setigerus*, three chromosome races ($2n = 34$, 36, and 54) have been isolated; whereas in *C. ciliaris*, as many as eight forms ($2n = 32$, 34, 36, 38, 40, 52, 54 and 56) are known (Ramaswamy *et al.*[1]). Although apomixis in *C. setigerus* has been demonstrated (Fisher *et al.*[2]) no attempts seem to have been made to find out the mechanism of apomixis in *C. ciliaris*. The list of apomictic grasses presented by Brown[3] did not include *C. ciliaris*. However the studies undertaken in the past suggested the presence of apomixis in this species. Such a suggestion was based on cytogenetic and breeding studies. Positive evidence for the presence or absence of apomixis can only be obtained from laborious and time-consuming studies of megaspore, embryo sac and embryo development. Due to the availability of squash technique now (Bradley[4]), this task of detection of apomixis in grasses has become easier.

During a recent cytological survey of grasses from Western Uttar Pradesh, three collections of *C. ciliaris* were studied from Meerut and Hastinapur. All of them showed irregular meiosis. The irregularities included the presence of univalents and multivalents at metaphase I, lagging chromosomes at anaphase I and anaphase II and the presence of micronuclei at dyad and quartet stages. In collection No. 667 where apomixis was worked out using squash technique, chromosome associations were worked out at metaphase I ($n = 18$) and the results are presented in Table I.

TABLE I

Chromosome associations at metaphase I

	I	II	III	IV	Xta/cell
Range ..	0– 2	6–18	0– 1	0– 6	31–38
Mean ..	0·24	10·68	0·16	3·48	34·64

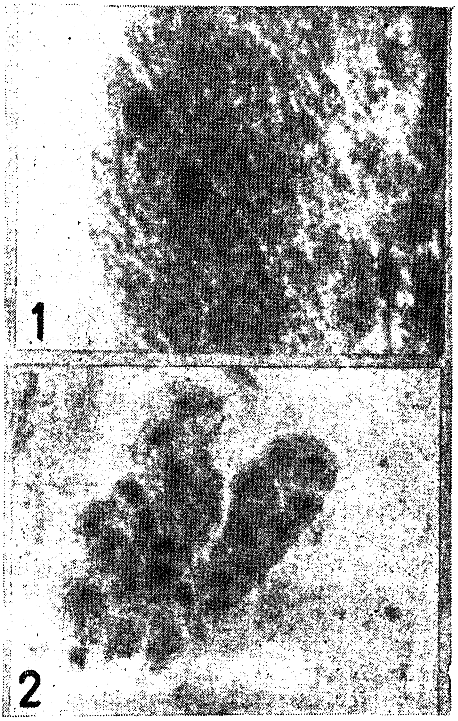
At anaphase I, 86·25% cells and at anaphase II 86·50% cells were normal, the remaining cells showing laggards and bridges. The meiotic irregularities suggested that apomixis may be common in the species. An attempt was, therefore, made to study the embryo sacs and the embryo development. Since section cutting is a time-consuming process, a modified Bradley's squash technique, suggested by D'Cruz and Reddy,[5] was followed.

The presence of multiple embyo sacs and multiple embryos was found to be common feature. From a total of 26 ovules studied, 17 showed the presence of multiple embryo sacs. Frequency distribution of the ovules having different numbers of embryo sacs is given in Table II. Most of these embryo sacs were not mature and were found in the form of initial cells or in the early stages of the embryo sac development (Fig. 1). In no case more than two mature embryo sacs were observed in the same ovule. This suggested that most of the embyo sacs which start their development never reached maturity. The additional embryo sacs were presumably nucellar in their origin. Polyembryony was observed in some of the ovules studied. In ovules, where embryos were found in their later stages of development, more than one embryo were never observed in the same ovule. This may be due to the very small sample studied. When polyembryony was observed, multiple embryos were found in the form of bunches (Fig. 2) suggesting cleavage polyembryony or adventive embryony. It will be difficult to establish their exact mode of development, unless microtome sections are

TABLE II

Frequency distribution of ovules with varying number of embryo sacs

Number of embryo sacs	1	2	3	4	5	6	7
Frequency of ovules ..	9	6	8	..	1	..	2



FIGS. 1–2 Fig. 1. A two-nucleate young embryo sac from squash technique. Fig. 2. One of the several bunches of embryos squashed from the same ovule.

used for study. Such a study is, however, underway.

Division of Plant Sci., P. K. GUPTA.
Meerut Univ. Inst. of YASHVIR.
Adv. Studies, Meerut, *January* 2, 1971.

1. Ramaswamy, K. R., Raman, V. S. and Madhava Menon, P., *J. Indian bot. Soc.*, 1969, **48**, 102.
2. Fisher, W. D., Bashaw, E. C. and Holte, E. C., *Agron. J.*, 1954, **46**, 401.
3. Brown, W. V., *Jour. South Afr. Bot.*, 1958, **24**, 191.
4. Bradley, W. V. *Stain Techn.*, 1948, **23**, 29.
5. D'Cruz, R. and Reddy, P. S., *Ibid.*, 1967, **42**, 237.

REVIEWS AND NOTICES OF BOOKS

Modern Aspects of Solid State Chemistry. Edited by C. N. R. Rao. (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y.), 1970. Pp. xiv + 103. Price $ 9.50.

Solid state chemistry, being an interdisciplinary field, is very vast and no single textbook can cover the entire field in detail. As the editor points out in his preface, this compilation is by no means complete. This volume, undoubtedly is of help to graduate students and to solid state scientists in general. Within the boundaries, the editor has done a reasonable job of linking the various chapters. The most impressive feature of the volume is that the articles were written by Chemists, Physicists, Metallurgists, etc., and as such there is a good blending of different disciplines.

V. R. PAI VERNEKAR.

Ultrasonic Transducer Materials. Edited by Oskar E. Mattiat. (Plenum Publishing Corporation, 227, West 17th Street, New York, N.Y. 10011, U.S.A.), 1971. Pp. ix + 185. Price $ 12.50.

This is the latest volume in the Ultrasonic Technology series of Monographs under the general editorship of L. Balamuth of the Ultrasonic Systems, Inc., New York. In recent years remarkable progress has been made in the development of materials for ultrasonic transducers, and there is a continuing trend towards increasingly higher frequency ranges for application of ultrasonic transducers in modern technology. Literature on the subject is scattered over numerous technical and scientific journals. A compact book as the present monograph presenting the state-of-the-art on the subject is a need and thus it will be widely welcomed by workers in this field of study.

Three specialists have contributed the three chapters in this monograph, Chapter I by Y. Kikuchi deals with magnetostrictive metals and piezomagnetic ceramics as transducer materials, Chapter II by Don Berlincourt covers piezoelectric crystals and piezoelectric (electrostrictive) ceramics. Chapter III by A. H. Meitzler focuses on piezoelectric materials and techniques for ultrasonic devices operating above 100 MHz.

A. S. G.

Annual Review of Physiology (Vol. 33). Editor: Victor E. Hall. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1971. Pp. ix + 661. Price: U.S.A. $ 10.00; Foreign $ 10.50.

The current volume of this well-known series of *Annual Review of Physiology* contains the following articles: "Catecholamine Functions", by J. Axelsson; "Action of Vertebrate Sex Hormones", by H. G. Williams-Ashman and A. H. Reddi; "Kidney", by Jack Orloff and Maurice Burg; Respiration: Alveolar Gas Exchange", by Jahannes Piiper and Peter Scheid; "Temperature Acclimation in Birds and Mammals", by R. R. J. Chaffee and J. C. Roberts; "Central Nervous System: Afferent Mechanisms", by R. W. Rodieck: "Nervous Function at the Cellular Level: Glia", by Arnaldo Lasansky; "Peripheral Mechanisms of Vision", by Paul Witkovsky; "Physiology of Hearing", by Donald H. Eldredge and James D. Muller: "Cyclic Nucleotides", by J. G. Hardman, G. A. Robison and E. W. Sutherland; "Motor Mechanisms: The Role of the Pyramidal System in Motor Control", by Vernon B. Brooks and S. David Stoney, Jr.; "Brain-Adenohypophysial Communication in Mammals", by F. E. Yates, S. M. Russell, and J. W. Maran; "The Regional Circulation", by Gordon Ross; "Heart: Excitation and Contraction", by Edward A. Johnson and Melvyn Lieberman; "Feeding: Neural Control of Intake", by Bartley G. Hoebel; and "Comparative Physiology: Gas Exchange and Circulation in Fishes", by Kjell Johansen.

A. S. G.

Natural Regulation of Animal Populations. Edited by Ian A. McLaren. (Aldine Publishing Company, 320, West Adams Street, Chicago, Illinois 60606), 1971. Pp. 195. Price : Cloth Bound $ 6.95 ; Paper Bound $ 2.95.

This book is the first we have received in the *Atherton Controversy* series. The purpose of this new series is to make available to the college teacher and his students tightly organized volumes presenting conflicting views of key controversial subjects in political science, sociology, psychology, and other fields. Each *Atherton Controversy* is edited by a scholar intimately acquainted with the topic who provides an Introduction establishing the basis for argument and outlining the issues. The body of the book consists of a careful selection of authoritative published papers that present contrasting views of the subject. Thus each volume in this series should provide thought-provoking material for classroom discussion and papers.

The present volume in the field of population ecology contains ten papers, published between 1958 and 1968, which focus attention on three main issues of the subject, namely, the effects of environment and population density on population dynamics, the influence of animal behaviour on population growth, and the possibilities of genetic feedback or short-term evolutionary change in control of animal populations. The editor Professor McLaren provides a well-analysed introduction on the scope of the subject and the points involved in the controversy.

A. S. G.

Liberal Arts Mathematics. By L. Spector. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London, W. 1, England), 1971. Pp. xv + 560, Price £ 4.35.

We are noticing great changes taking place in recent years in the content and method of teaching mathematics in schools and colleges and a number of books are appearing in the market. The book under review presents the year of Mathematics now offered at Borough of Manhattan Community College, the City University of New York. The course intended for liberal arts students is both mathematical and capable of being understood. The stress in the treatment is more verbal than notational or symbolic as is the practice in usual text-books of this kind. This is a well brought-out production which is extremely interesting and intellect sharpening. The Quiz at the end of each section is as important as the text. It teaches the student to understand the text and prepares him to go ahead.

The contents cover a wide range from "numerals and numbers", through "Godel's proof" to "Pyramids and Pascal's triangle".

The book will also interest the general reader in providing creative mental exercise on mathematics, logic and language.

A. S. G.

Applications of Holography. Edited by E. S. Barrekette, W. E. Knock, T. Ose, J. Tsujiuchi and G. W. Stroke. (Plenum Publishing Corporation, 227, West 17th Street, New York, N.Y. 10011, U.S.A.), 1971: Pp: viii + 396. Price $ 16.50.

This volume contains primarily the proceedings of the second U.S.–Japan Seminar on holography, held in Washington, D.C. from October 20–27, 1969 under the auspices of the National Academy of Sciences, National Science Foundation, and the Japanese Society for the Promotion of Science. In addition to the papers presented at the seminar, several others are included because they cover important applications which are appropriate to this volume. Attendance at the seminar was limited and selective being confined to specialists and hence the papers presented are from recognized authorities on the particular aspect of holographic application.

The book is invaluable for engineers and researchers interested in current and future commercial applications of holography and coherent optics in such areas as metrology optical data processing, aperture synthesis, and computer systems.

Among the topics included are 3-D construction of imaginary objects, correction of lens aberration, non-linear holographic interferometry, computer synthesis of holograms and spatial filters, Radar and microwave applications, holographic technique applied to eye and vision research.

A. S. G.

Low-Frequency Vibrations of Inorganic and Co-ordination Compounds : By J. R. Ferraro. (Plenum Press, New York), 1971. Papers 310. Price $ 18.50.

The present book is the second in the rapidly-growing field of 'Far Infared Spectroscopy' as applied to inorganic and co-ordination compounds. This book, by Prof. Ferraro, covers the low-frequency vibrations from 650 cm^{-1} downwards. The book clearly demonstrates the usefulness of the far infrared region with or without the aid of other methods of study.

A major portion of the book is devoted to metal-ligand vibrations connected with metal-oxygen, metal-halide and metal-nitrogen; and are based on symmetry considerations. Extensive tabulation of the frequencies are neatly made and some correlations regarding metal-ligand vibrations drawn. Wherever appropriate, the higher frequency vibrations are also considered. Other metal-ligand vibrations where the ligand donor atoms are sulfur, selenium, tellurium, phosphorus, arsenic or metal are briefly discussed. Organometallic compounds (metal-carbon vibrations) are not included.

The book covers in fair detail the history, instrumentation, calibration and sampling techniques. A discussion of the slow-neutron scattering and high-pressure techniques used to aid far infrared assignments is included. Other applications, to ion-pairs, trapped molecules in clathrates, electronic transitions and lattice vibrations, are also outlined. Two appendices are given. Appendix 1 contains table of symmetries for the space groups and group correlation tables; and Appendix 2, an outline of the factor group analysis of solids.

The book is intended for chemists and spectroscopists working on inorganic and co-ordination compounds in the far infrared region. This objective is fully realised. It is a very useful reference book for research workers. Sufficient information on far infrared spectroscopy is available so that the book could be of use for teaching purpose also. The reviewer feels that persons who already possess a copy of Prof. Nakamoto's excellent little book, *Infrared Spectra of Inorganic and Co-ordination Compounds'* [John Wiley (1963)] would be greatly benefitted by adding this book to their Library.

The literature has been covered up to 1969 and a large number of references cited. There are a few typographical errors. Repetition of references in individual chapters could have been avoided.

D. N. S.

ANNOUNCEMENTS

Symposium on Cellular Processes in Growth, Development and Differentiation

The Biology and Medical Committee Symposium—1971/1972 on Cellular Processes in Growth, Development and Differentiation will be held at the Bhabha Atomic Research Centre, Trombay, Bombay, from November 22nd to November 24th, 1971. Deadlines for Abstracts—September 15th, 1971, and for Papers—October 31st, 1971.

The topics will include Phage DNA phenotypes and morphogenesis; Regulatory mechanisms in prokaryotes and eukaryotes; Homeostatic mechanisms; Macromolecular, sub-cellular and cellular changes in differentiation; Specific antigens and cytodifferentiation; Abnormal cell proliferation in higher organisms; and Senescence and ageing.

Correspondence regarding the symposium should be addressed to: Dr. P. R. Mahadevan, Biology Division, Bhabha Atomic Research Centre, Bombay-85.

Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Zoology to Shri R. V. Ramasastry.

The M.S. University of Baroda has awarded the Ph.D. degree in Botany to Shri G. Prathapasenan.

Sri Venkateswara University, Tirupati, has awarded the Ph.D. degree in Physics to Shri C. V. Raghavan; Ph.D. degree in Chemistry to Smt. S. Indubala.

Books Received

Biochemistry of Brain and Behaviour. Edited by R. E. Bowman and S. P. Dutta. (Plenum Pub. Corpn.), 1971. Pp. xi + 364. Price $ 16.50.

Principles of Lithogenesis. Edited by S. I. Tomkeieff and J. E. Hemingway. (Plenum Pub. Corpn.), 1970. Pp. x + 577. Price $ 32.00.

Current Problems in Fertility. Edited by A. Ingelman-Sundberg Bils-Olovlunell. (Plenum Pub. Corpn.), 1971. Pp. xv + 244. Price $ 12.50.

Neuropoisons, Their Patho-Physiological Actions (Vol. I)—*Poisons of Animal Origin.* Edited by L. L. Simpson. (Plenum Pub. Corpn.), 1971. Pp. xiv + 361. Price $ 22.50.

2971-71. **Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.**

BASIC DYKES SEQUENCE IN THE PRECAMBRIAN COMPLEX SOUTH-EAST OF TURA, GARO HILLS, MEGHALAYA, ASSAM

B. C. BAROOAH
Directorate of Geology and Mining, Shillong, Assam

ABSTRACT

Basic dykes and sills of three widely differing periods have affected the Precambrian rocks exposed south-east of Tura, Garo Hills. From their metamorphic history and structural behaviour not only the sequence of their emplacement but the conditions of the country rock during the periods of their emplacement have been deciphered. Basite-Metadolerite-Basaltic dykes and sills is the order of sequence seen.

INTRODUCTION

NO large-scale mapping of any area in the Precambrian exposures in Assam has been undertaken so far. During the period November 1968 to May 1969, the writer had the opportunity to carry out such mapping in an area covering 5 sq km south-east of Tura (90° 30′ 35″ E : 25° 30′ 53″ N ; Fig. 1, inset), the headquarters of the Garo Hills District, Assam. The result had been very revealing and forms the subject of a different communication. Here it is proposed to deal only with the basic hypabysal rocks traversing the series of ancient crystalline rocks.

The Precambrian complex forms a prominent physiographical feature in the area south-east of Tura and mainly comprises of biotite schist, quartzofeldspathic gneiss, calc schist and calc gneiss all of which intruded by basic intrusives of different ages and granite (Fig. 1). These basic intrusives show different structural behaviour and have different metamorphic history. From their grade of metamorphism and from their varying structural patterns a definite order of sequence can be established such as Basite-Metadolerite-Basaltic dykes and sills.

BASITE

The earliest of the basic intrusives in the area are the basite. Narrow, only 30 cm to 8 m across and of limited areal extent upto 700 m in length (Fig. 1), they are mostly concordant masses showing an E-W to ENE-WSW trend.

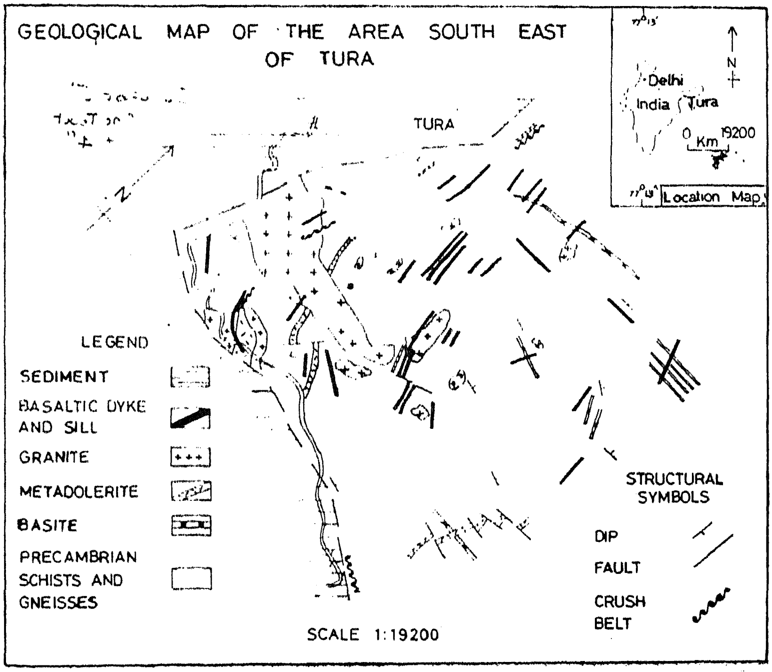

GEOLOGICAL MAP OF THE AREA SOUTH EAST OF TURA
TURA
N
Delhi
India
Tura
0 Km 19200
Location Map
LEGEND
SEDIMENT
BASALTIC DYKE AND SILL
GRANITE
METADOLERITE
BASITE
PRECAMBRIAN SCHISTS AND GNEISSES
STRUCTURAL SYMBOLS
DIP
FAULT
CRUSH BELT
SCALE 1:19200

FIG. 1. Geological map of the area south-east of Tura, showing the distribution of different basic intrusives and granite. (Thickness of some of the basic masses is slightly exaggerated.)

They have sharp contact with the country rock and rarely show discordant relation. Usually foliated but sometimes strongly so, they commonly exhibit marked lineation. The foliation is generally parallel to the margins and is affected by later deformations. Plagioclase (An$_{32-39}$), hornblende and biotite are the chief constituents but quartz also is present in small quantity. The rock rarely shows relict subophitic texture. Subhedral hornblende grains with schiller structure indicate complete replacement (conversion) of pyroxene into hornblende. Elongate flakes of biotite show preferred orientation and discordant relation to hornblende, indicating their growth after hornblende. Epidote, ilmenite, sphene, magnetite and rare garnet occur as accessories. The mineralogical composition approximates that of a metamorphosed basic igneous rock, which is suggestive of an igneous origin for the rock.

METADOLERITE

A suite of NW-SE to N-S-trending metadolerite dykes are of common occurrence in the area (Fig. 1). They show discordant relation with schists and gneisses cutting them at acute angles but rarely at right angles and at places they cut the basite also (Fig. 1). These dykes vary from 5 m to 60 m across and can be followed for few kilometres. Usually, they are medium to coarse-grained and characterized by sub-ophitic texture near the centre grading off to a fine-grained margin. In the fresh centres of the rock, plagioclase, pyroxene and hornblende are the main constituents but hornblende is dominant ferro-magnesian mineral in the amphibolitized variety. Plagioclase (An$_{30-50}$) with complex twinning, occurs as lath-shaped clouded crystals and constitutes the major part of the rock. Pyroxene mostly augite ($Z\wedge c = 42°$) with rare hypersthene forms euhedral prismatic crystals, but usually clouded due to exsolution. Even in the least amphibolitized centres, hornblende ($Z\wedge c = 18°$) is present but in variable amount as individual prismatic primary plates and as rims around iron ore and pyroxene. Irrespective of the mode of origin, all hornblende show identical optical properties. Magnetite, ilmenite, quartz and rare garnet occur as accessories.

BASALTIC DYKES AND SILLS

Of very common occurrences in the area is a swarm of basaltic dykes and sills of varying trend and composition (Fig. 1). Individual dykes and sills vary in thickness from less than 10 cm to 30 m and can be followed for considerable distances. The trend of the dykes and sills varies from N-S to NNW-SSE and E-W to ENE-WSW respectively. Usually medium-grained, there are varieties which are fine-grained. They cross-cut the basite, metadolerite and the granite as also the dominant foliation of the schist and gneiss. Four petrographic types of these dykes and sills have been recognized, namely, dolerite, olivine dolerite, tachylite and granophyre of which dolerite is the most widespread, the others being of limited occurrence. Plagioclase (An$_{35-45}$) and pyroxene are the dominant minerals in the dolerite which exhibits both ophitic and porphyritic textures. In olivine dolerite, the dominant minerals are olivine, plagioclase (An$_{45-60}$) and pyroxene and it is characterized by porphyritic and ophitic textures. Mostly tachylite occurs as narrow selvage to dolerite dykes and sills, constitutes mainly of brownish glass densely charged with a separation of magnetite. Only a single instance of granophyre was noticed in the area near the Deputy Commissioner's bungalow. All the basaltic dykes and sills are fresh and show little alteration. At places they are affected by mylonitization and brecciation, however.

DISCUSSION AND CONCLUSIONS

In the basite, considerable mineralogical changes have occurred due to metamorphism and no relict pyroxene is seen. The foliation of the rock is mostly parallel to that of the schist and gneiss indicating its development with the dominant foliation of the country rock. The foliation of the basite has, however, been affected by subsequent deformations. Although the metadolerite is partially amphibolized, no secondary fabric has developed, which is indicative of the emplacement of the metadolerites having taken place in stress-free environments. The altered margins, however, indicate emplacements in hot country rocks following (brought about by) regional metamorphism. The metadolerite dykes cross-cut the basites (Fig. 1), hence are younger in age. The basaltic dykes and sills cross-cut the basite and metadolerite (Fig. 1), have chilled margins which latter fact emphasises that they were emplaced in cold country rocks after the close of regional metamorphism. Mylonitization and brecciation of the basaltic dykes and sills are due to brittle movements at depth. Petrographically these basaltic dykes and sills differ from the Sylhet trap occurring elsewhere in Assam (Murthy, personal communication) and may be older than the Sylhet trap which is of Upper Jurassic in age.

From the evidences described, it would appear that the basic intrusives affected the Precambrian rocks in the south-east of Tura in three distinct periods separated by wide intervals of quiescence. Due to lack of necessary data, it is not possible to date these periods more precisely, not according to tectonic movements. The varying conditions of the country rock during which each type was emplaced can, however, be easily recognized. During the emplacements of basites, an amphibolite facies of metamorphism was prevalent and the country rock was in stress. The metadolerite dykes were emplaced in stress-free environments but in elevated temperatures, while the basaltic dykes and sills were emplaced in cold country rocks.

ACKNOWLEDGEMENTS

The author is grateful to Sree S. K. Barooah, A.R.S.M., Ex-Director of Geology and Mining Directorate, for his various useful suggestions. Thanks are also due to Dr. M. V. N. Murthy, Director, Geological Survey of India, Eastern Circle, Shillong, Assam, for his constructive criticism and help rendered in petrological study.

CONVECTION OVER A NATURALLY PERMEABLE BED

B. M. RAJASEKHARA, B. K. RAMAIAH AND N. RUDRAIAH

Visvesvaraya College of Engineering, Bangalore University, Bangalore

ABSTRACT

The temperature distribution for a poiseuille flow over a naturally permeable bed is presented for the two cases, conducting and insulating upper plate. It is found that, the temperature distribution increases linearly in the case of insulating wall, whereas, it is parabolic in nature, in case of conducting wall. It is also found that, the Nusselt number increases steadily up to the value of $\sigma = 2$ and it is uniform for $\sigma > 2$; where $\sigma = h/\sqrt{k}$. h is the distance between the upper plate and the permeable bed and k is the permeability of the bed.

1. INTRODUCTION

THE poiseuille flow of a Newtonian fluid over a porous surface and the corresponding slip boundary condition at the permeable wall has been investigated, both theoretically and experimentally, by Bevers and Joseph (1967). Their results show that the rectilinear flow of a viscous fluid over the surface of a permeable material induces a boundary layer region, within the material. The effect of this boundary layer is to alter the nature of the tangential flow near the nominal boundary. The slip boundary condition proposed by them is in agreement with their experimental data. They have shown that the discharge is greatly enhanced over the value it would have if the bed were impermeable, indicating the presence of a boundary layer in the bed. Throughout their analysis, they have considered only the velocity of the flow but not the temperature distribution in the bed. Since there exists a boundary layer, *i.e.*, viscous dissipation in the bed, we should take into account, however small, the variation of temperature induced by the viscous dissipation. This is one of the convection problems over a permeable surface.

In general, the problem of convection consists of the transport of heat by a moving fluid in which variation of temperature, and hence of density, produces a distributed buoyancy force that itself modifies the flow pattern. This interaction of density and velocity fields is the essential feature of convection. Thus to find the convection in poiseuille flow both the velocity and temperature fields must be determined together, throughout the whole region of flow. Solutions of this kind are mathematically complicated and in such circumstances simple problems like forced and free convection are usually studied theoretically in detail.

In forced convection problem, the density of the flow is regarded entirely unaffected by the heat transfer, which therefore acts only to mark parts of fluid passing near certain boundaries. These marked elements are swept away in the flow produced by externally applied forces (namely the applied pressure in the poiseuille flow) and are distributed throughout the region by convection and diffusion, without affecting the field of flow in any way. This amounts to finding the temperature distribution due to heated or cooled boundaries in a specified velocity field. However, in the problem of free convection the motion of fluid is caused solely by the buoyancy forces due to the action of some field of force on the unevenly unheated fluid.

The aim of the present paper is to consider only the problem of forced convection taking the velocity field as given by Bevers and Joseph and assuming the Muskat model. The corresponding problem of free convection will be presented elsewhere.

2. Basic Equations and Solutions of the Problem

We consider the steady rectilinear flow of a viscous fluid through a two-dimensional parallel channel formed by an impermeable upper wall $y = h$ and a permeable lower bed $y = 0$. The plane $y = 0$ defines a nominal surface for the permeable material. A uniform pressure gradient is maintained in the longitudinal direction both in the channel and in the impermeable material. The flow through the body of the permeable material is given by Darcy's law

$$Q = -\frac{k}{\mu} \times \frac{dp}{dx} \tag{1}$$

where k is the permeability of the material, Q is the volume of flow rate per unit cross-sectional area, and μ is the viscosity.

The free flow between the permeable surface and the rigid upper boundary having the horizontal component of velocity u is governed by the Navier-Stokes equation. For this problem Bevers and Joseph (1967) has given the velocity distribution in the form:

$$u = u_B\left(1 + \frac{a}{\sqrt{k}} y\right) + \frac{1}{2\mu}(y^2 + 2ay\sqrt{k})\frac{dp}{dx} \tag{2}$$

where the slip velocity is given by

$$u_B = -\frac{k}{2\mu}\left(\frac{\sigma^2 + 2a\sigma}{1 + a\sigma}\right) \times \frac{dp}{dx} \tag{3}$$

with

$$\sigma = \frac{h}{\sqrt{k}}.$$

The temperature distribution is given by the energy equation

$$\frac{\partial^2 T}{\partial y^2} + \frac{\mu}{K}\left(\frac{du}{dy}\right)^2 = 0 \tag{4}$$

where μ is the viscosity and K is the thermal diffusivity of fluid. The boundary condition on the temperature distribution at the permeable surface is

$$\frac{dT}{dy} = \beta(T_B - T_0) \quad \text{at} \quad y = 0. \tag{5}$$

The boundary condition on the temperature at the impermeable surface will depend on the nature of the material of the plate. If the upper plate is conducting the boundary condition is

$$T = T_0 \quad \text{at} \quad y = h \tag{6}$$

If the upper plate is insulating, the boundary condition, since no heat can pass through it, is

$$\frac{dT}{dy} = 0 \quad \text{at} \quad y = h. \tag{7}$$

Making equations (2) to (7) dimensionless, using the quantities

$$V = \frac{u}{u_0},\ V_B = \frac{u_B}{u_0},\ \theta = \frac{T}{T_0},$$

$$\eta = \frac{y}{h},\ \gamma = \frac{x}{h} \tag{8}$$

where u_0 is the maximum velocity in the channel, T_0 is the room temperature, we obtain

$$V = -\frac{R}{2} \times \frac{dp_0}{dr}(1 - \eta^2) + a\sigma\left(V_B + \frac{R}{\sigma^2} \times \frac{dp_0}{dr}\right)(\eta - 1) \tag{9}$$

$$V_B = -\frac{R}{2\sigma} \times \frac{(\sigma + 2a)}{(1 + a\sigma)} \times \frac{dP_0}{dr} \tag{10}$$

$$\frac{d^2\theta}{d\eta^2} = -\xi\left(\frac{dV}{d\eta}\right)^2 \tag{11}$$

and the corresponding boundary conditions are:

(*i*) When the upper plate is conducting

$$\theta = 1 \quad \text{at} \quad \eta = 1$$

$$\frac{d\theta}{d\eta} = a\sigma(\theta_B - 1) \quad \text{at} \quad \eta = 0 \tag{12}$$

(*ii*) When the upper plate is insulating

$$\frac{d\theta}{d\eta} = 0 \quad \text{at} \quad \eta = 1$$

$$\frac{d\theta}{d\eta} = a\sigma(\theta_B - 1) \quad \text{at} \quad \eta = 0 \tag{13}$$

where

$$R = \frac{u_0 h}{\nu}$$

is the Reynolds number.

$$\xi = P_r(E_c)$$

$$P_r = \frac{\mu g c_p}{K}$$

is the Prandtl number

$$E_c = \frac{u_0^2}{g c_p T_0}$$

is the Eckert number

When the upper plate is conducting, the temperature distribution is given by

$$\theta = 1 - \xi\left[\frac{\alpha\sigma\{2b^2 + (a + 2b)^2\}(1-\eta)}{12(1+\alpha\sigma)} - \frac{b^2}{2}(1-\eta^2) - \frac{ab}{3}(1-\eta^3) - \frac{a^2}{12}(1-\eta^4)\right] \tag{14}$$

where

$$b = \frac{a\alpha(2-\sigma^2)}{2\sigma(1+\alpha\sigma)},\quad a = \mathrm{R}\frac{dp_0}{dr}. \tag{15}$$

In this case the Nusselt number N, defined by

$$\mathrm{N} = \frac{-\left(\frac{\partial\theta}{\partial\eta}\right)_{\eta=1}}{\theta_B - 1} \tag{16}$$

is given by

$$\mathrm{N} = \frac{(2a+3b)^2(1+\alpha\sigma) + 3b^2(1-\alpha\sigma) - \alpha\sigma(a^2+4ab)}{2b^2 + (a+2b)^2}. \tag{17}$$

Also, when the upper plate is insulating, the temperature distribution is given by

$$\theta = 1 + \frac{\xi}{3\alpha\sigma}[b(a+2b) + (a+b)^2] + \frac{\xi}{3}[b(a+2b) + (a+b)^2]\eta - \xi\left[\frac{b^2}{2} + \frac{ab}{3}\eta + \frac{a^2}{12}\eta^2\right]\eta^2. \tag{18}$$

3. DISCUSSION

Temperature distribution given by equations (14) and (18) are numerically evaluated and it is observed that in the case of insulating upper wall the variation of temperature is linear whereas in the case of conducting upper wall, the variation of temperature is parabolic in nature.

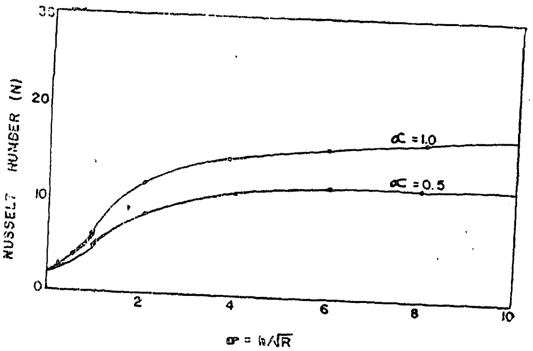


FIG. 1 Nusselt number *vs.* permeability.

The Nusselt number given by equation (17) is numerically evaluated for different values of σ, a and α and is shown in Fig. 1, for $a = 1$. We observe that, when α increases, the Nusselt number increases steadily up to the value of $\sigma = 2$ and for $\sigma > 2$, the Nusselt number is uniform. Typical behaviour is observed for other values of a.

---

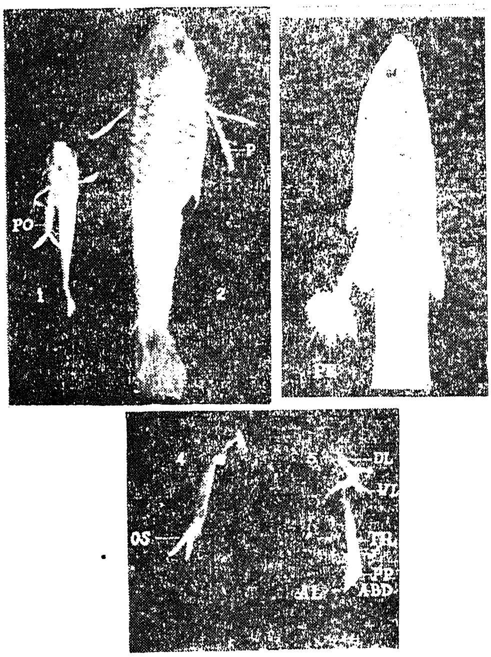
1. Beavers, S. G. and Joseph, D. D., *J. Fluid Mech.* 1967, **30**, Part I, 197.

A NEW COPEPOD PARASITE, *LERNAEA* SP. NOV., ON A CYPRINODONT FISH, *LEBISTES RETICULATUS* (PETERS)

H. R. SRINIVASACHAR AND A. SUNDARABAI
Department of Zoology, University of Agricultural Sciences, Hebbal, Bangalore-24

THE genus *Lernaea* was established by Linnaeus[4] in the year 1746 based on the type species *L. cyprinacea* parasitic on the Cyprinoid fishes. Since then, several species of *Lernaea* have been reported parasitic on different species of freshwater fishes in various parts of the world[5] (Yamaguti, 1963). But in India two species, *L. bengalensis* and *L. chakoensis* have been described by Gnanamuthu[1-3] (1951 *a*, 1951 *b*, 1956). None of the above species of *Lernaea* so far reported appears to be parasitic on *Lebistes* (Guppy). The authors collected over 663 specimens of the female copepod parasites during November 1969–May 1971 from the host fishes, *Lebistes reticulatus* from an experimental tank in Hesaragatta (15 miles from Bangalore) and the present species of copepod parasite (Figs. 1 to 5) appears to be different both in its morphology and life-history from the other species of *Lernaea* so far described.

The adult female parasite measures from 6 to 9 mm in length and the multiserial ovisacs are 2–3 mm long (Fig. 4, OS). Over 120–140 eggs are observed in a single fully developed ovisac. The parasites are found buried 2–3 mm deep in the body of the fish and they are generally found to be attached at the basal region of pectoral (Figs. 1, 2), anal, ventral and caudal fins. Occasionally, some of them are also found attached behind the dorsal fin and on the ventral region of the fish (Fig. 3). Usually only one parasite is found attached to a host fish and very rarely more than two are found. The parasite has a highly branching anchor-like part in the anterior end and this part of the body together with the head is buried in the tissues of the host (Figs. 1, 2). The anchor shews asymmetrical extensive branching arms with the dorso-lateral arms (Fig. 5, DL) longer than the ventro-lateral ones (VL). The branching of arms of the anchor varies with the age of the parasite. The adult parasite has a distinct three-segmented abdomen (ABD) and the pregenital prominence (PP) is an undivided lobe extending ventrally. The posterior end of the abdomen which is slightly flat terminally bears a pair of anal laminae (AL). Each lamina has a long straight seta extending posteriorly.



FIGS. 1-5. **Figs. 1-3.** The parasitic copepod, *Lernaea hesaragattensis* sp. nov. on *Lebistes reticulates*, ×2. Fig. 4. Ventral view of the parasite *Lernaea hesaragattensis* sp. nov. (pulled out from the host fish), × 3·5. Fig, 5. Lateral view of the parasite *Lernaea hesaragattensis* sp. nov. (pulled out from the host fish), ×3·5. Key: ABD, abdomen; AL, anal lamina; DL, dorso-lateral arm; OS, ovisac; P, adult parasite without ovisacs; PE, adult parasite with partial encrustations of peritrichous ciliates and algae; PO. adult parasite with fully formed ovisacs; PP, pregenital prominence; TR, trunk; VL, ventro-lateral arm.

In a number of cases the parasites are covered completely or partially by encrustations of peritrichous ciliates (Vorticellids, *Epistylis* sp.), diatoms and algae (Fig. 3, PE). Although some species of *Lernaea* parasitic on the larger fishes like *Cyprinus carpio, Osphronemus goramy, Catla catla,* etc., are not fatal to the host fish, it has been observed that the present species of *Lernaea* on *Lebistes* appear to be fatal to the host fish. Invariably the fishes brought to the laboratory infected with the adult female copepod parasites died within 48 hours from the time they were brought from the tank. Whenever the parasites were removed or damaged, the host fish always continued to live for months in the laboratory. Probably this is due to the smallness in the size of the fish and the parasite feeding on the tissue fluids of the host fish.

In the case of *Lernaea chakoensis* (Gnanamuthu, 1951)[1] parasitic on *Catla catla* and *Osphronemus goramy*, anchor arms are symmetrical in possessing two laterodorsal and two ventral arms of equal size and branching, the pregenital prominence is divided and the lobes are not as long as abdomen. The anal lamina bears curved seta with two outer and one inner spine. While in the case of other species, *Lernaea bengalensis* described by Gnanamuthu[3] (1956) parasitic on *Channa punctatus*, the anchor arms (cephalic arms) are four simple anterior (Dorso-lateral) arms shorter than posterior (Ventro-lateral) and unlobed arranged crosswise, the pregenital prominences are in the form of two large rounded lobes to form a "heel". The posterior end of the abdomen carries slender long tapering setae.

In addition to the above characters, the two species *L. chakoensis* and *L. bengalensis* (Gnanamuthu, 1951, 1956)[1,3] differ from the present species of *Lernaea* in a number of other characters like the mouth parts, thoracic appendages and host specificity. In view of the differences noticed, the present species of *Lernaea* is treated as new species and is named as *Lernea hesaragattensis* sp. nov. after the place from where the parasites have been collected. The holotype of the species of the parasite at present is deposited in the Department of Zoology, University of Agricultural Sciences, Hebbal, Bangalore, and will be sent to the Indian Museum and British Museum of Natural History, London.

The specific characters of the new species of *Lernaea* are as follows:

Cephalic (anchor) arms are four and unequal branching, dorso-lateral arms are longer than ventro-lateral. The arms are simple straight (unlobed) in young and become highly branching (lobed) and asymmetrical in adult. Head almost circular, projects anteriorly, neck distinct and show swelling at the region of second pair of legs. First antennae longer with four joints bear 21 spines and second antennae, three-jointed, bear 10 spines. The pregenital prominence is in the form of undivided single bulged lobe. The anal lamina bears one outer and one inner spine as well as long straight spine (seta).

The detailed investigations on the morphology, life-history, incidence of the parasites and control are under progress and the papers on the above will be communicated later.

ACKNOWLEDGEMENTS

Our thanks are due to Mr. Jinadattaraya of Fisheries Department, and Mr. P. Nair of University of Agricultural Sciences, who helped us in the collection of the infected fishes. Our thanks are also due to Mr. G. S. Winifred, Photo-artist, UAS, for helping us in taking the photographs.

1. Gnanamuthu, C. P., "*Lernaea chakoensis*, n. sp., a copepod parasitic on two Madras fishes," *Parasitology*, 1951 *a*, **41** (2-4), 143.
2. —, "Notes on the life-history of a parasitic copepod *Lernaea chakoensis*," *Ibid.*, 1951 *b*, **41** (2-4), 148.
3. —. "*Lernaea bengalensis* sp. nov.: a copepod parasitic on *Channa punctatus*," *Rec. Ind. Mus.*, 1956, **54** (1-2), 5.
4. Linnaeus, (Linne), C. A., *Fauna suecica, Stockholmise*, 1746-61, 1st ed. 1746 (Not referred in original).
5. Yamaguti, S., *Parasitic Copepoda and Branchiura of Fishes*, Interscience Publishers, New York. 1963.

CHEMISTRY AND PHARMACOLOGY OF THE MAJOR ALKALOID OF *FUMARIA INDICA* (HAUSSK) PUGSLEY

V. B. PANDEY AND B. DASGUPTA
Department of Medicinal Chemistry

S. K. BHATTACHARYA, R. LAL AND P. K. DAS
Department of Pharmacology,
Institute of Medical Sciences, Banaras Hindu University, Varanasi-5 (India)

ABSTRACT

The chemical and pharmacological studies show that the smooth muscle relaxant and hydrocholeretic effects of *F. indica* are due to protopine which is present as the major alkaloid in the plant. As a smooth muscle relaxant protopine was found to be slightly weaker than papaverine.

FUMARIA (Papaveracea) is a genus of herbs distributed in Asia, Europe and Africa. Practically all the species are known by the name *fumitory*. According to *The Wealth of India*[1] the Indian plant bearing the name 'Shehterah' or 'Pit-papra' has been wrongly referred to by many authors as *Fumaria officinalis* Linn. or *Fumaria parviflora* Lam., which are the common fumitory of Europe, and are not found in India. In the revision of the genus *Fumaria*, Pugsley[2] considered the correct name of the Indian species to be *Fumaria indica* (Haussk), and gave the distinguishing features of this species from the other allied ones, namely, *F. vaillantii* Loisel and *F. parviflora* Lam. The chemical evidence, recorded in this paper, also indicates that they are distinctly different species.

The plant, *F. indica*, is distributed over the greater part of India upto 8,000′ on the Himalayas and Baluchistan. In the indigenous systems of medicine, the plant is regarded as a laxative, diuretic, alterative, diaphoretic and is said to be beneficial in dyspepsia, liver complaints and scrofulous skin affections.[1,3]

Pharmacological studies by Bhattacharya *et al.*[4] revealed that the water-soluble fraction of 90% ethanol extract and the total tertiary alkaloidal fraction of *F. indica* possessed relaxant and non-specific antispasmodic activity on isolated intestines and uterii of different species of animals, and on intravenous administration showed a moderate but prolonged hydrocholeretic effect. In view of this pharmacological activity of the plant, coupled with its extensive use in removing hepatic obstructions and fevers in clinical cases by Ayurvedic physicians, we undertook a detailed chemical investigation of the plant. Only one alkaloid, protopine, has been reported to have been isolated so far from the Indian species of *Fumaria* by previous workers.[5,6]

In a recent short communication,[7] we have reported the occurrence of seven isoquinoline alkaloids in *F. indica*, of which four are previously unreported in nature. We report here the isolation of the major alkaloid, protopine, its characterisation and pharmacological actions.

Chemical.—Dried and milled whole plant of *Fumaria indica* (4 kg), collected locally, was extracted exhaustively by cold percolation with rectified spirit. The solvent-free dark-brown gummy residue was made into a slurry with methanol (500 ml). The slurry was poured into water and sufficient hydrochloric acid was added to make the solution distinctly acidic to congo (6 l water, 120 ml conc. HCl). Steam under pressure was passed through the solution for about 4 hr to remove methanol completely. The solution was kept in the cold for 3 days, and filtered from the separated gummy material. The clear acidic solution was extracted exhaustively with chloroform (20 × 1 l) to separate chloroform-soluble base hydrochlorides (A) from chloroform-insoluble base hydrochlorides (B). The two fractions, A and B, were then fractionated into phenolic and non-phenolic bases separately. The individual alkaloids were isolated by repeated chromatographic resolution over Brockmann neutral alumina, monitoring at every stage for homogeneity over silica gel G chromatoplates using different solvent mixtures as developers and Dragendorff's reagent for the staining.

The dark-brown residue (26·5 g) left after removal of solvent from the chloroform solution of base hydrochlorides (A) was repeatedly boiled with dilute hydrochloric acid (2%), and the solution filtered from insoluble residue. The combined acidic solution was extracted with ether, and then basified with excess potassium hydroxide. When the precipitate of non-phenolic bases (3·06 g) became granular on standing, it was filtered off, washed with water, and dissolved in a mixture of chloroform and methanol. The clear filtrate on concentration yielded light-brown plates, which were repeatedly crystallised from chloroform-methanol mixture after treatment with activated charcoal, when protopine, $C_{20}H_{19}O_5N$, was obtained as plates and prisms (600 mg), m.p. 207-209°, R_f 0·35 (methanol), 0·00 (chloroform-methanol, 50 ml : 1 drop). Protopine could also be obtained by adding ether to the methanolic solution of the precipitate of non-phenolic bases, or by concentrating the benzene-soluble portion of the precipitate.

Anal.—Calcd. for $C_{20}H_{19}O_5N$: C, 67·98 ; H, 5·42 ; N, 3·96. Found : C, 67·70, 68·05 ; H, 5·59, 5·66 ; N, 3·97, 4·25.

Spectroscopic Data.—Infrared $\nu_{\text{max.}}$ 1660 cm^{-1} [CO absorption due to conjugation[8] between >CO and >NCH_3] : ultraviolet $\lambda_{\text{max.}}^{\text{EtOH}}$ 240 (shoulder), 290 (log ϵ 3·95) mμ [lit.[9] $\lambda_{\text{max.}}^{\text{EtOH}}$ 293 (log ϵ 3·93) mμ] ; n.m.r. δ 1·92 (3 H), 2·55 (2 H), 2·88 (2 H), 3·58 (2 H), 3·78 (2 H), 5·86 (2 H), 5·90 (2 H), 6·52, 6·6, 6·62 (4 H, complex[10]) ; mass spectrum m/e 353 (M^+, 38), 338 (8), 322 (7), 309 (17), 295 (11), 281 (29), 267 (41), 252 (27), 237 (12), 223 (11), 209 (16), 204 (12), 190 (88), 177 (21), 176 (11), 163 (94), 149 (83), 148 (100), 134 (45), 89 (38), 76 (27), 42 (20).

The aqueous acidic solution (B) left after removal of chloroform-soluble base hydrochlorides was made distinctly alkaline with ammonium hydroxide, and extracted exhaustively with chloroform (20 × 1 l). The combined chloroform extract on removal of solvent yielded a dark-brown gummy mass (8·85 g) which on crystallisation from chloroform-methanol mixture afforded the major portion of protopine as plates (1·6 g), m.p. 206-208°. The yield of the seven alkaloids from *F. indica* whole plant (4 kg) as reported by us[7] is as follows : (1) protopine, 2·45 g ; (2) tetrahydrocoptisine, 40 mg ; (3) a tautomeric form of fumariline,[11] a homogeneous gum, $C_{20}H_{17}O_5N$, (M^+ 351), 58 mg ; (4) a racemic mixture of bicuculline and its optical antipode (not known in nature), $C_{20}H_{17}O_6N$, m.p. 234-235°, $[\alpha]_D^{20} \pm 0$, 37 mg ; (5) bicuculline, 8 mg ; (6) *fumarilicine*, a homogeneous gum, $C_{20}H_{19}O_5N$ (M^+ 353), 12 mg ; (7) *narceimine*, $C_{22}H_{21}O_9N$, m.p. 264-265°, 44 mg.

Pharmacological.—In view of the earlier observation[4] that the total tertiary alkaloids of *F. indica* have smooth muscle relaxant and hydrocholeretic activities, pharmacological studies were conducted on the major alkaloid, protopine, present in *F. indica*. Papaverine hydrochloride was used as a control.

(*a*) *Smooth Muscles.*—Protopine produced a moderate to marked relaxation of isolated ileum of guinea-pig, rabbit and albino rat in concentrations of 0·5 to 5·0 mcg/ml. It also inhibited spontaneous activity of isolated uterus of albino rat in concentrations of 2 to 10 mcg/ml. Protopine was found to be approximately equipotent to papaverine. Protopine was found to have a non-specific spasmolytic action against spasms induced by DMPP, acetylcholine bromide, histamine dihydrochloride, barium chloride, 5-hydroxytryptamine, creatinine sulphate and oxytocin on isolated ileum of guinea-pig and albino rat and uterus of albino rat. A comparison of spasmolytic ED 50 of protopine and papaverine in different test preparations showed that protopine was about 50% to 90% as potent as papaverine. Protopine in doses of 5 mg/kg I.V. produced marked relaxation of intestine *in situ* of anaesthetised dog without producing any significant effect on blood pressure. In equivalent dose papaverine produced intestinal relaxation along with significant hypotension.

(*b*) *Biliary Secretion*.—In anaesthetised dog (with cystic duct ligated and common bile duct cannulated), protopine in the dose of 5 mg/kg I.V. produced a 2·5-fold rise in biliary flow at 1 hr after drug administration. The effect lasted for more than 2½ hr. Protopine did not significantly increase the solid constituents of the bile. Papaverine in the dose of 10 mg/kg had no such hydrocholeretic effect.

(*c*) *Miscellaneous*.—Protopine did not have any significant effect on perfused frog heart, and faecal and urinary output in albino rats. It was devoid of any acute toxicity upto a dose of 50 mg/kg I.P. in albino rats.

1. *The Wealth of India, Raw Materials*, C.S.I.R., New Delhi, 1956, **4**, 68.
2. Pugsley, H. W., *J. Linn. Soc.*, 1919, **44**, 313.
3. Chopra, R. N., Chopra, I. C., Handa, K. L. and Kapur, L. D., *Indigenous Drugs of India* U. N. Dhur & Sons, Calcutta, 1958, p. 674; Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glossary of Indian Medicinal Plants*, C.S.I.R, New Delhi, **1956**, p. 122.
4. Bhattacharya, S. K., Lal, R., Sanyal, A. K. and Das, P. K., *Ind. J. Pharmacol.*, **1969**, **1**, 8; Bhattacharya, S. K., Lal, R., Sanyal, A. K., Dasgupta, B. and Das, P. K., *J. Res. Ind. Med.*, **1970**, **4**, 152.
5. Agarwal, R. R., *Proc. Nat. Inst. Sci.* (*India*), 1937, **3**, 319.
6. Govindachari, T. R., Nagarajan, K., Pai, B. R. and Rajappa, S., *J. Sci. Ind. Res.* (*India*), 1958, **17B**, 73.
7. Pandey, V. B., Dasgupta, B. and Ghosal, S., *Experientia*, communicated.
8. Anet, F. A. L., Bailey, A. S. and Robinson, R., *Chem. & Ind.*, 1953, p. 944.
9. Sangster, A. W. and Stuart, K. L., *Chemical Review*, 1965, **65**, 69.
10. *NMR Spectra Catalogue* (*Varian AG*), Spectrum No. 339.
11. Saunders, J. K., Bell, R. A., Chen, C. Y., Maclean, D. B. and Manske, R. H. F., *Can. J. Chem.*, 1968, **46**, 2873, 2876 and previous papers.

SECOND GENERAL CONGRESS OF THE SOCIETY FOR THE ADVANCEMENT OF BREEDING RESEARCHES IN ASIA AND OCEANIA (SABRAO)

It is proposed to hold the Second Congress of the Society for the Advancement of Breeding Researches in Asia and Oceania from February 19 to February 25, 1972, at the Indian Agricultural Research Institute, New Delhi, India. The Congress is being organised under the auspices of the Indian Society of Genetics and Plant Breeding.

The proceedings of the Congress would include, *inter alia*: (*i*) Presentation of papers including authoritative reviews by invited speakers; (*ii*) Pre and Post-Congress tours to research institutes in India in different regions concerned with different areas of scientific research; (*iii*) An Exhibition, the themes of which will be "High Yielding Varieties", "Breeding for Nutritional Quality" and "New Trends in Animal Improvement"; (*iv*) Special lectures on topics of wide interest will also be arranged.

For further particulars, please write to Dr. M. V. Rao, Secretary, Organizing Committee, Second General Congress, Cummings Laboratory, Indian Agricultural Research Institute, New Delhi-12, India.

LETTERS TO THE EDITOR

ANGULAR CORRELATION STUDY ON THE 321-177 keV CASCADE IN ^{125}Te

THE decay scheme of ^{125}Sb is extensively investigated by various spectroscopic studies,—some of the recent investigations being those of Inamura,[1] Stone *et al.*[2] and Graue *et al.*[3] The spins of the 145, 321 and 642 keV states are established to be 11/2⁻, 9/2⁻ and 7/2⁺ respectively. The multipole mixing of the 177 keV transition occurring between 9/2⁻ and 11/2⁻ states is determined from L-subshell conversion electron measurements[4] as 72% M1 + 28% E2. There exists an inconsistency on the quadrupole content of the 321 keV (7/2⁺ → 9/2⁻) transition. A finite contribution of M2 to E1 transition is an indication of E1 hindrance which may be due to the difference in the structure of the states. The multipole mixing ratio of this transition being of great interest, a reinvestigation is considered desirable. A conventional fast-slow coincidence assembly was employed in this work.[5] The spectra were recorded on a 100-channel analyser.

The coincidence spectrum recorded at 90° with gate at 177 keV is shown in Fig. 1. It can be seen from the figure that the peak at 428 keV arises due to the coincidences of the 172, 178·8 and 209 keV transitions which are included in the present gate setting. The coincidence events arising out of the 428 keV Compton events falling under the photopeak of 321 keV are subtracted by taking the area riding over the Compton continuum as shown in Fig. 1. The coincidence events due to the 204-177 keV cascade, however, do not contribute to the 321 keV photopeak.

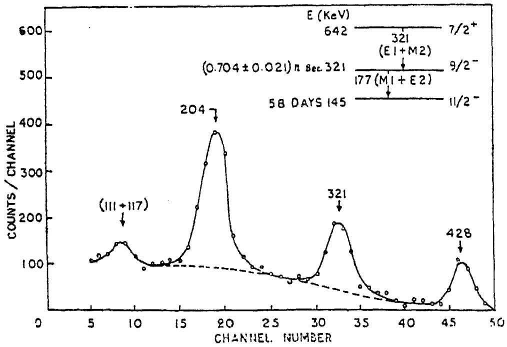


FIG. 1. Gamma-ray coincidence spectrum observed at 90° gated at 177 keV.

The coincidence spectra are recorded for three angles, 180°, 135° and 90° between the detectors. At each angle, a pooled total of 10,000 counts are collected and they are fitted to a polynomial of the type

$$W(\theta) = 1 + A_2P_2(\cos\theta) + A_4P_4(\cos\theta)$$

using White's[6] method after correcting the count rates for chance and interfering coincidences. The correlation coefficients are corrected for finite detector sizes employing the experimentally determined values of attenuation coefficients. The corrected values of the correlation coefficients are given in Table I together with the values of the previous investigations.

TABLE I

Correlation coefficients for the 321-177 keV cascade

Reference		A_2	A_4
Inamura[1]	..	$-0 \cdot 169 \pm 0 \cdot 027$	$+0 \cdot 018 \pm 0 \cdot 034$
Champion *et al.*[7]	..	$-0 \cdot 594 \pm 0 \cdot 026$	$+0 \cdot 028 \pm 0 \cdot 068$
Knapek *et al.*[8]	..	$-0 \cdot 165 \pm 0 \cdot 004$	$-0 \cdot 007 \pm 0 \cdot 005$
Wyly *et al.*[9]	..	$-0 \cdot 150 \pm 0 \cdot 020$	$-0 \cdot 040 \pm 0 \cdot 040$
Cruse *et al.*[10]	..	$-0 \cdot 168 \pm 0 \cdot 012$	$-0 \cdot 003 \pm 0 \cdot 015$
Present work	..	$-0 \cdot 126 \pm 0 \cdot 012$	$-0 \cdot 069 \pm 0 \cdot 013$

It can be seen from Table I that the values of A_4 in all cases are vanishingly small. The values of A_2 of the previous investigations fall into two categories. The value of A_2 of Champion *et al.*[7] is unusually large and predicts a large quadrupole content in the 321 keV transition (7%). On the other hand, the other group of A_2 values predict smaller quadrupole content (less than 1%). Using the quadrupole content $Q_{177} = 0 \cdot 28 \pm 0 \cdot 02$ reported by Mazets *et al.*[2] from the L-subshell conversion ratio measurements and negative sign of δ_{177}, the mixing ratio analysis of the 321-177 keV correlation is made employing Arns and Wiedenbeck's[11] method for mixtures in both transitions in the cascade. The present value of A_2 is used to estimate the quadrupole content as ($0 \cdot 07 \pm 0 \cdot 05\%$) which is in agreement with the latter group.

It is interesting to note that the E1 transition occurring between the 642 keV (7/2⁺) and the 321 keV (9/2⁻) states does not show a hindrance to enable a large quadrupole content to get admixed in it. The 321 keV state was interpreted in some earlier investigations[2,8] to be a 3-quasi-particle intruder state. In the investigations carried out by the present authors[5] the 321 keV state was observed to be more of a phonon addition type to the 145 keV ($h_{11/2}$) state. If the 642 keV state has a character of 7/2⁺, it may be interpreted as a $g_{7/2}$ state or a $g_{7/2}$ particle part admixed to the phonon addition to other particle states in the major shell ($d_{5/2}$, $d_{3/2}$ and $s_{1/2}$). It is rather difficult to explain under these conditions the predominant E1 nature of the 321 keV transition.

Laboratories for Nuclear Research,
Andhra University,
Waltair, A.P., *July* 9, 1971.

GUMMADI SATYANARAYANA.
V. LAKSHMINARAYANA.

---

1. Inamura, T., *J. Phys. Soc. Japan*, 1968, **24**, 1.
2. Stone, N. J., Frankel, R. B. and Shirley, D. A., *Phys. Rev.*, 1968, **172**, 1243.
3. Graue, A., Lien, J. R., Royrvik, S. and Aaroy, O. J., *Nucl. Phys.*, 1969, **136 A**, 513.
4. Mazets, E. P. and Sergeenkov, Yu. V., *Izv. Akad. Nauk. SSSR* (Ser. fiz), 1966, **30**, 1185.
5. Satyanarayana, G., *Ph.D. Thesis.*, Andhra University, 1971.
6. White, D. M., *Nucl. Inst. & Methods*, 1963, **21**, 209.
7. Champion, J. R. and Arya, A. P., *Bull. Am. Phys. Soc.*, 1970, **15**, 623.
8. Knapek, E. *et al.*, *Phys. Letters*, 1969, **29 B**, 581.
9. Wyly, L. D. *et al.*, *Phys. Rev.*, 1970, **1**, 2062.
10. Cruse, D. W. *et al.*, *Nucl. Phys.*, 1970, **154 A**, 369.
11. Arns, R. G. and Wiedenbeck, M. L., *Phys. Rev.*, 1958, **111**, 1631.

ROTATIONAL ANALYSIS OF D-X BAND SYSTEM OF CuBr MOLECULE

FOUR band systems are known for the CuBr molecule, namely, A system (4600–5100 Å), B system (4200–4600 Å) C system (3900–4000 Å) and D system (3700–4000 Å). The A, B, C systems have been analysed by Ritschel[1] and Rao and Rao.[2] The D system was obtained in emission recently by Rao and Rao.[3] There four band systems have a common lower X$^1\Sigma$ state as the ground state of the molecule.

In the present study, the bands of D system of CuBr molecule have been photographed in the second order of 10·6 meter concave grating spectrograph having the dispersion 0·33 Å/mm. The rotational analyses of (2, 0) and (0, 1) bands have been carried out.

The transition of D system was predicted as $^1\Sigma$–$^1\Sigma$ by Rao and Rao.[3] Due to two equally abundant isotopes, *i.e.*, ^{63}Cu^{79}Br and ^{63}Cu^{81}Br (7 : 7) the rotational structure of the bands presents a complex look. However, we have succeeded in tracing out the P and R equally intense branches due to these isotopes in (0, 1) and (2, 0) bands. Respective combination differences between P and R branches of ^{63}Cu^{81}Br for (0, 1) and (2, 0) were compared with the respective bands of C–X system analysed by Rao and Rao.[2] The rotational isotopic shifts in the P and R branch lines due to ^{63}Cu^{81}Br have been found to be in good agreement with the calculated shifts. The rotational constants are summarized in Table I.

TABLE I
Molecular constants of D–X system of CuBr

(0, 1)		(2, 0)	
$^{79}\nu_0$	= 25211·20 cm^{-1}	$^{79}\nu_0$	= 26077·50 cm^{-1}
$^{81}\nu_0$	= 25209·30 cm^{-1}	$^{81}\nu_0$	= 26074·30 cm^{-1}
$^{79}B_0'$	= 0·0926 cm^{-1}	$^{79}B_2'$	= 0·0907 cm^{-1}
$^{79}B_1''$	= 0·1005 cm^{-1}	$^{79}B_0''$	= 0·1004 cm^{-1}
$^{81}B_0'$	= 0·0917 cm^{-1}	$^{81}B_2'$	= 0·0895 cm^{-1}
$^{81}B_1''$	= 0·0995 cm^{-1}	$^{81}B_0''$	= 0·0993 cm^{-1}

The authors are thankful to C.S.I.R., New Delhi, India, for financial help.

Dept. of Spectroscopy,
Banaras Hindu University,
Varanasi-5,
June 30, 1971.

BADRI RAI.
R. K. PANDEY.
S. N. RAI.
A. K. CHAUDHARY.

---

1. Ritschel, R., *Z. Physik.*, 1927, **42**, 172.
2. Rao Ramakoteswara and Rao Appa, K. V. S. R., *Cand. J. Phys.*, 1967, **45**, 2805.
3. — and —, *Proc. Ind. Acad. Sci.*, 1964, **60**, 57.

DEBYE PARAMETER AND VIBRATION AMPLITUDE OF SODIUM

ABSTRACT

Accurate Bragg intensity data at room temperature were collected from three single crystals of metallic sodium grown from melt, using CuKα radiation in the equi-inclination Weissenberg setting. The integrated intensities were measured on a microdensitometer and corrected for secondary extinction. Structure factor-least squares refinement of the thermal parameter, with correction for thermal diffuse scattering, gave the final B value at 300° K as $B = 7 \cdot 64 \pm 0 \cdot 08$ Å². The r.m.s. amplitude of thermal vibrations, $(u^2)^{\frac{1}{2}}$, and the Debye characteristic temperature, Θ, at 300° K are 0·54 Å, and 140·1 ° K, respectively.

RECENTLY, the temperature dependence of Debye–Waller factor of Na has been investigated theoretically using the Kreb's model, by Singh and Sharma[1]. The only experimental work has been the very early X-ray study of Dawton[2]. We have now determined the Debye–Waller factor of metallic sodium, at room temperature from accurate X-ray intensity data from 3 single crystals, grown from melt (along [111] direction), in quartz and Lindemann capillaries. Slowly cooled crystals gave much lower intensities for low angle reflections than fast cooled ones, indicating that the latter were better suited for X-ray diffraction work.

Accurate Bragg intensities of 12 independent reflections, from these 3 samples were collected on multiple films, using CuKα radiation, in the equi-inclination Weissenberg setting. The integrated intensities were measured on a microdensitometer. The intensity data were corrected for Lorentz-polarisation factor, spot shape, and absorption. Cromer and Waber[3] form factors, f_{Na}, corrected for anomalous dispersion were used. Figure 1 shows the presence of extinction effects on the low angle reflections. The final B value was obtained by structure factor least squares refinement using secondary extinction corrected intensities, with g factors of 0·0022, 0·0048 and 0·0061, for samples 1, 2 and 3 respectively.

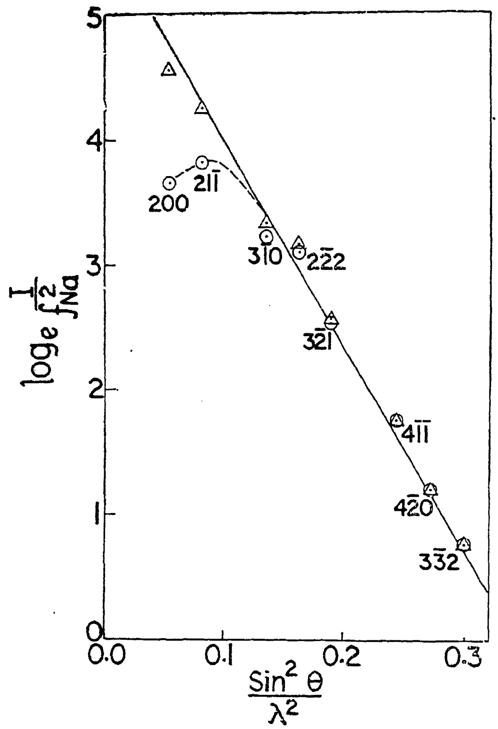


FIG. 1. ⊙ Intensities not corrected for extinction. △ Intensities corrected for secondary extinction.

Table I gives the results of the present study. B_{TDS} refers to B value corrected for thermal diffuse scattering, by Lucas method[4], the required elastic constants having been taken from Daniels[5]. Also listed in the table is the B value at room temperature as taken from the plot given by Singh and Sharma[1], theoretically calculated on the Kreb's model. This plot gives the values of $(B_T - B_0)$ only. With the reference B_0 taken equal to that calculated from Dawton's intensities given at the lowest temperature (117° K), the B value at room temperature 300° K is equal to 5·1 Å^2.

TABLE I

Observed, F_o, and calculated, F_c, structure factor data (given for sample 1 only). Debye parameter, B, Debye characteristic temperature, Θ, and r.m.s. amplitude of thermal vibrations. $(\overline{u^2})^{\frac{1}{2}}$, at room temperature are also given.

h	*k*	*l*	No. of measurements	F_0	F_c
2	0	0	4	11·10	11·11
1	1	2	26	8·51	8·36
2	0	2	18	6·40	6·33
3	1	0	24	4·64	4·82
2	2	2	2	3·91	3·69
1	2	3	40	2·88	2·84
4	0	0	4	2·13	2·20
3	0	3	6	1·72	1·70
4	1	1	12	1·61	1·70
4	2	0	5	1·12	1·33
3	3	2	4	0·93	1·04
2	2	4	2	0·81	0·82

R-factor : 2·55% ; B = 6·94 Å^2 (E.S.D. in B = 0·08 Å^2).

Present value, with TDS correction (averaged over the 3 samples):
$B_{TDS} = 7\cdot64 \pm 0\cdot08$ Å^2; $\Theta = 140\cdot1$° K; $(u^2)^{\frac{1}{2}} = 0\cdot54$ Å.
Dawton's[2] : B = 6·87 Å^2; $\Theta = 146\cdot0$° K.
(calculated from his intensity data)
Singh and Sharma[1] : B = 5·1 Å^2.

Dept. of Physics, S. KRISHNA KUMAR.
Indian Inst. of Sci., V. VALVODA.*
Bangalore-12, India, M. A. VISWAMITRA.
June 2, 1971.

---

* Present address: Charles University, Department of Solid-State Physics, Prague-2, Czechoslovakia.

1. Singh. A. K. and Sharma, P. K., *J. Phys. Soc. Japan*, 1969, **26**, 425.
2. Dawton, R. H. V. M., *Proc. Phys. Soc.* (*London*), 1937, **49**, 294.
3. Cromer, D. T. and Waber, J. T., *Acta Cryst.*, 1965, **18**, 104.
4. Lucas, B. W., *Ibid.*, 1969, **25 A**, 627.
5. Daniels. W. B., *Phys. Rev*, 1960, **119**, 1246.

STEPWISE FORMATION OF SOME BIVALENT METAL ION COMPLEXES OF N-ACETYLACETONEANTHRANILIC ACID

ALTHOUGH salicylaldimine complexes[1,2] have been extensively investigated, very little work is known to have been done on β-ketoamine complexes. A close examination of the survey reveals that the stabilities of the complexes of N-acetylacetoneanthranilic acid (abbr. H_2AA) with Co^{+2}, Ni^{+2}, Cu^{+2}, Zn^{+2} and Cd^{+2} have not been studied and hence this work was undertaken. The measurements were carried out in 50% dioxane at 30 ± 0·1° C as the H_2AA and the metal complexes are insoluble in water.

Precision pH meter (Type : OP-205, No. 837) with a wide range glass electrode and a calomel reference electrode was used for pH measurements. The electrode system was calibrated at two pH values (4·0 and 7·0) with suitable buffers.[3] The chemicals used were of AnalaR (BDH) grade and their solutions were prepared in air-free conductivity water. Standard carbonate-free sodium hydroxide solution in 50% dioxane was used as a titrant.[4] The H_2AA was prepared,[1] its requisite quantity was dissolved in freshly distilled dioxane and the solution standardised potentiometrically.

The Calvin-Bjerrum pH-titration technique[5,6] as used by Irving and Rossotti,[7] was employed to investigate the stabilities of H_2AA and its metal complexes. For this purpose, the following solutions (total volume 20 ml) were titrated against 0·1 N NaOH and the titration curves were plotted: (*i*) 5·0 ml 0·01 M $HClO_4$ + 2·0 ml 1·0 M $NaClO_4$ + 10·0 ml dioxane + 3·0 ml water; (*ii*) 5·0 ml 0·01 M $HClO_4$ + 2·0 ml 1·0 M $NaClO_4$ + 10·0 ml 0·01 M H_2AA + 3·0 ml water; (*iii*) 5·0 ml 0·01 M $HClO_4$ + 2·0 ml 1·0 M $NaClO_4$ + 10·0 ml 0·01 M H_2AA + 2·0 ml 0·01 M metal ion solution + 1·0 ml water.

The formation curve (Fig. 1) of H_2AA extends upto $\bar{n}_A = 2$, indicating that two dissociable protons are present in the ligand; this is also obvious from its structure. The values of its protonation constants, as obtained by "Interpolation at half n_A values" are $\log K_1^H = 9 \cdot 72$ and $\log K_2^H = 6 \cdot 30$ and by "Interpolation at various $\bar{n}_A$ values" are $\log K_1^H = 9 \cdot 73$ and $\log K_2^H = 6 \cdot 29$.

The formation curves (Fig. 2) of the metal-ligand systems representing $\bar{n}$ *versus* pL were plotted. The approximate values of formation constants were read directly from the formation curves using Bjerrum half $\bar{n}$ method.[5] Refinement of these constants was done by "Correction term" and "Successive approximations" methods.[8] The values obtained by all these methods are in fair agreement. In the case of Cu^{+2}, and Cd^{+2} complexes, 1 : 1 species is formed having $\log K_1$ values of 10·48 and 4·36 respectively. Ni^{+2}, Co^{+2} and Zn^{+2} complexes involve stepwise formation of 1 : 1 and 1 : 2 species, having $\log K_1$ and $\log K_2$ values of 6·42 and 4·29; 5·92 and 3·95, and 4·98 and 4·29 respectively.

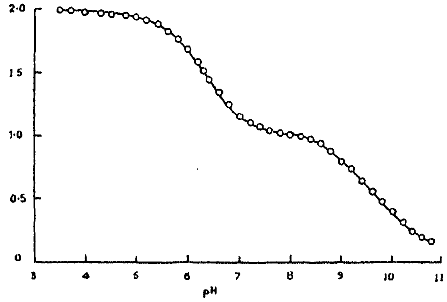


FIG. 1. Formation curve of proton—ligand system of H_2AA.

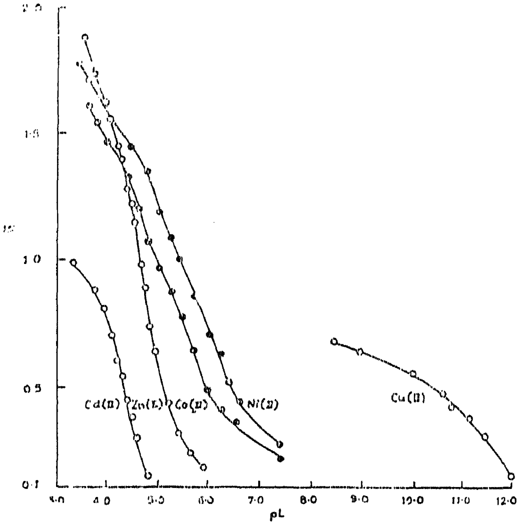


FIG. 2. Formation curves of bivalent metal complexes with H_2AA.

It is evident from these data that the stability constants of these complexes are in the order: Cu > Ni > Co > Zn > Cd. Thus, the order of stabilities of the transition metal complexes is in agreement with the Irving and Williams rule.[9] Further, these values of stability constants are comparable with those found in the case of corresponding N-salicylaldimineanthranilic acid complexes.[10]

The authors wish to express their thanks to the University Grants Commission, New Delhi, for the award of research scholarship to one of them (V. C. S.).

Dept. of Chemistry, R. K. Mehta.
University of Jodhpur, R. K. Gupta.
Jodhpur, *April* 21, 1971. V. C. Singhi.

1. Holm, R. H., Everett (jr.), G. W. and Chakravorthy, A., *Progress in Inorganic Chemistry*, Interscience Publishers, New York, 1966.
2. Mehta, R. K., Rao S. P. and Kapoor, R. C., *J. Ind. Chem. Soc.*, 1969, **7**, 933.
3. Goel, D. P., Trikha, K. C. and Singh, R. P., *Ind. J. Chem.*, 1968, **6**, 662.
4. Vogel, A. I., *A Text Book of Quantitative Inorganic Analysis*, (Longmans, Green & Co., Ltd., London), 3rd edn., 1961, p. 241.
5. Bjerrum, J., *Metal Ammine Formation in Aqueous Solution* (P. Hasse and Son, Copenhagen), 1941.
6. Calvin, M. and Wilson, K. W., *J. Am. Chem. Soc.*, 1945, **67**, 2003.
7. Irving, H. and Rossotti, H. S., *J. Chem. Soc.*, 1953, p 2904.
8. — and —, *Ibid.*, 1954, p. 3397.
9. —, and Williams, R. J. P., *Chem. Soc.*, 1953, p. 3129.
10. Authors Paper under publication.

ORGANO-SULFUR COMPOUNDS: DIESTERS OF SULFUROUS ACID

Abstract

Mixed diesters of sulfurous acid have been synthesised and their PMR spectra were studied in relevance with magnetic non-equivalence of two ester moieties.

Alkyl sulfites have been reported to possess insecticidal[1] properties. So the synthesis of alkyl (aryl) sulfites was undertaken. We have synthesised unsymmetrical alkyl (aryl) sulfites in two steps. Thus, when 2-phenyl ethyl alcohol is treated with slightly more than equimolar quantity of thionyl chloride in presence of pyridine the halosulfinate (I) results as follows:

The halosulfinate is then reacted with 2-methoxy phenol leading to the formation of 2-phenyl ethyl O-methoxy phenyl sulphite (II).

It is a high boiling liquid. Its IR spectrum[2] shows S=O band at 1220 cm^{-1} and S–O–C at 749 cm^{-1}. The PMR spectrum of (II) contains a singlet due to three methoxy protons at 3·81 δ; methylene protons give triplets at 3·60 δ (2 H, J = 7 cps) and at 3·06 δ (2 H, J = 7 cps). The aromatic protons (9 H) absorb in the range 6·8–7·2 δ. Abnormal splitting of the methylene proton signal in di-isopropyl[3] and diethyl sulfite[4] have been recently reported.[5] This magnetic non-equivalence of methylene protons have not been observed in the PMR spectrum of 2-phenyl ethyl O-methoxy phenyl sulfite. Even the PMR spectrum of mthyl *n*-butyl sulfite displays fine structure pattern in the methylenic band system centered at about 3·75 δ. This may be attributed to the absence of symmetrical methylenic structure in their molecule.

2-Phenyl ethyl O-methoxy phenyl sulfite on boiling for two hours under reflux with 0·1–0·5 N aqueous sodium hydroxide was quantitatively decomposed into its components (Found: SO_2, 21·2%; $C_{15}H_{16}SO_4$ requires SO_2, 21·9%).

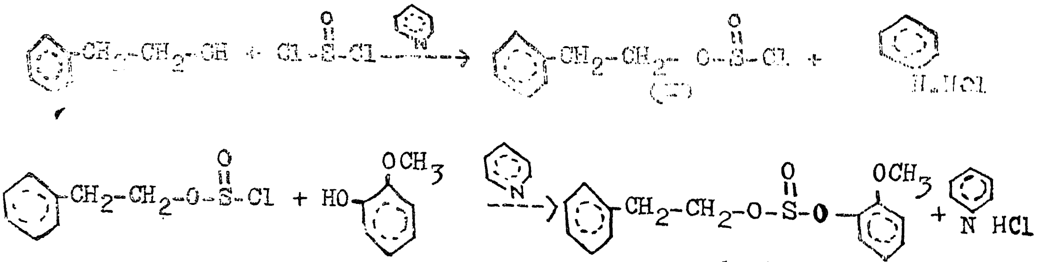
Experimental*

B.ps. are uncorrected. IR spectra were measured in Perkin-Elmer model 521 spectrometer. PMR measurements were made on a varian A-60 D spectrometer with TMS on an internal standard.

Synthesis of halosulfinates

Methyl chlorosulfinate.—Obtained from MeOH and $SOCl_2$; slight yellow fuming liquid, b.p. 78° C/500 mm; lit.[6] 19° C/13 mm.

2-Phenyl ethyl chlorosulfinate.—2-Phenyl ethyl alcohol and $SOCl_2$ gave 2-phenyl ethyl chlorosulfinate as colourless fuming liquid, b.p. 90° C/10 mm.



(II)

---

* We thank Mr. A. H. Siddique, I.I.T., Kanpur, for the elemental micro analysis and IR spectra and Dr. P. C. Jain, C.D.R.I., Lucknow, for PMR spectra.

Synthesis of Sulfites

Methyl n-butyl sulfite—0·05 Mole of methyl chlorosulfinate and 0·05 mole of *n*-butyl alcohol were mixed together and pyridine (0·05 mole) dissolved in 25 ml of dry benzene was added dropwise under nitrogen bubbling at ≤ 10° C with vigorous stirring. After the exothermic reaction was over, the mixture was allowed to stand overnight at room temperature. The suspension containing the pyridine hydrochloride was washed several times with 50 ml portions of distilled water and dried over anhydrous sodium sulphate. From the dried benzene extract, solvent was removed and residue fractionated under reduced pressure which gave sulfite as light yellow liquid, b.p. 92°/10 mm.; n_D^{35} 1·427, Yield 52·1%, Found: C, 39·22; H, 7·76; S, 21·21; $C_5H_{12}SO_3$ requires: C, 39·47; H, 7·89; S, 21·52: IR spectrum (thin film) λ_{max} 1206 cm^{-1} (S O), 704 cm^{-1} (S–O–C).

Methyl p-bromophenyl sulfite.—Obtained from methyl chlorosulfinate and *p*-bromophenol. Dark brown liquid boiling at 80° C/8 mm. n_D^{26} 1·592, yield 56·01%, Found: C, 33·46; H, 2·62,; S, 12·43; $C_7H_7BrSO_3$ requires C, 33·46; H 2·78; S, 12·78; IR spectrum (thin film) λ_{max} 1190 cm^{-1} (S O), 700 cm^{-1} (S O–C).

2-Phenyl ethyl p-tert-amyl phenyl sulfite.—2-phenyl ethyl chlorosulfinate gave 67·3% of the sulfite with *p*-tert-amyl phenol. It is a colourless liquid boiling at 82° C/9 mm; n_D^{36} 1·5200. Found: C, 68·48; H, 7·06; S, 9·35; $C_{19}H_{24}SO_3$ requires: C, 68·67; H, 7·22; S, 9·63; IR spectrum (thin film) λ_{max} 1176 cm^{-1} (S O), 697 cm^{-1} (S–O–C).

2-Phenyl ethyl O-methoxy phenyl sulfite.—Obtained from 2-phenyl ethyl chlorosulfinate and O-methoxy phenol. Colourless liquid, b.p. 60–62°/10 mm. yield 52·5%, n_D^{36} 1·526. Found: C, 61·47; H, 5·22; S, 10·61; $C_{15}H_{16}SO_4$ requires: C, 61·64; H, 5·47; S, 10·95.

The authors are grateful to Prof. R. C. Srivastava, Head of the Chemistry Department, for providing research facilities.

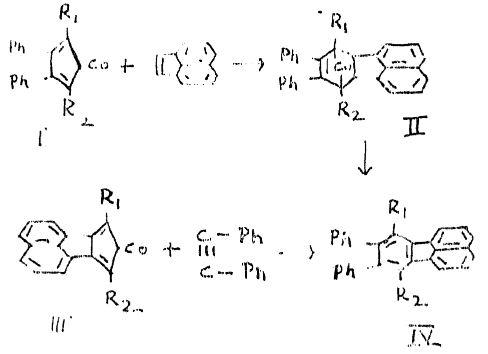
Dept. of Chemistry, RAMJI SHUKLA.
H.B. Technological Inst., R. S. TEWARI.
Kanpur-2, *April* 26, 1971.

---

1. Dean, A., *J. Econ. Entomol.*, 1968, **61**, 1044.
2. Simon, A., Kriegsmann, H. and Dutz, H., *Chem. Ber.*, 1956, **89**, 2390.
3. Mand, B., *Tetrahedron lett*. 1968, **44**, 4653.
4. Finegold, H., *J. Phys. Chem.*, 1969, **73**, 4020.
5. Jackman, L. M. and Sternhell, S., *Application of NMR Spectroscopy in Organic Chemistry*, Pergamon Press), 1968, p. 52.
6. Shirm, E., *Chem. Ber.*, **44**, 319; *Chem. Abstr.*, **1911, 5, 1603.**

SYNTHESIS OF FLUORANTHENE DERIVATIVES

THE dienophilic character of acenaphthylene was reported by E. Bergmann[1] and others and this is an important synthetic route into fluoranthene series based on the reaction of acenaphthylene and cyclopentadienones.[1] In all these cases except (*d*) and (*e*) it had been found that the carbonyl-bridge adduct (II) was formed when the cyclopentadienones (I) and acenaphthylene were refluxed in benzene. When adduct (II) was boiled in tetralin, decarbonylation as well as dehydrogenation[2] took place simultaneously forming fluoranthene derivatives (IV). The same fluoranthene derivatives (IV) except (*a*) were also prepared directly by heating a mixture of dienones (III) and diphenyl acetylene in an oil-bath at a temperature (130–150° C) at which carbon monoxide was evolved. The steps are indicated below and their melting points are given in Table I.



(*a*) R_1 R_2 CH_3; (*b*) R_1 R_2 C_2H_5
(*c*) R_1 R_2 n-C_3H_7; (*d*) R_1 R_2 n-C_4H_9
(*e*) R_1 R_2 n-C_5H_{11}; (*f*) R_1 Ph: R_2 CH_3
(*g*) R_1 Ph: R_2 C_2H_5; (*h*) R_1 Ph: R_2 n-C_3H_7

TABLE I

	M.P. °C II	IV		IV
(*a*)	198	246	..	..
(*b*)	205	212	Picrate	247
(*c*)	198	260	T.N.B.	288
(*d*)	..	145	Picrate	214
(*e*)	.	118	,,	206
(*f*)	205	223	,,	140
(*g*)	212	231	T.N.B.	268
(*h*)	213	233	Picrate	238

All the fluoranthene derivatives (IV) are pale yellow, crystallised from benzene and alcohol mixture, and give greenish fluorescence in benzene. Melting points are not corrected.

Microanalyses was done in Alfred Bernhardt's Laboratory, W. Germany.

Organic Chem. Lab., A. J. BHATTACHARJEE.
University of Burdwan, S. N. MANDAL.
Burdwan, West Bengal,
India, *March* 31, 1970.

---

1. Bergmann, E., *Nature*, 1948, **161**, 389.
2. Dilthey, W. and Co-workers, *Ber.*, 1938, **71**, 974.

CHEMICAL COMPONENTS OF THE STEM BARK OF *CEDRUS DEODARA*: ISOLATION OF A NEW DIHYDROFLAVONOL

IN an earlier publication[1] was reported the isolation of 'deodarin' from the ether extract of the stem bark and it was assigned the tentative structure of 3′, 4′, 5, 6-tetrahydroxy-8-C-methly dihydroflavonol. It was considered to be individual based on paper chromatography. A careful re-examination of this product using TLC in various solvent systems and polyamide and silica gel column chromatography has led its resolution into two components, compounds A and B, almost is equal quantities.

Compound A had the molecular formula $C_{15}H_{12}O_7$, m.p. 239-41° C, $[\alpha]_D + 12°$ (MeOH). Its colour reactions indicated it to be a dihydroflavonol. It formed a tetramethyl ether, m.p. 169-70° C and a penta-acetate, m.p. 120° C. The physical and spectral properties of compound A and of its derivatives led to its identification as taxifolin and this was confirmed by direct comparison of its methyl ether with an authentic sample.

Compound B had the molecular formula $C_{16}H_{14}O_7$, m.p. 226-27° C, $[\alpha]_D + 19°$ (MeOH). It gave colour reactions characteristic of a dihydroflavonol. Its U.V. spectra with and without reagents were comparable with those of taxifolin. $\lambda_{\text{max.}}^{\text{MeOH}}$ 293 (4·33) and 331 (inf) nm. It formed a tetramethyl ether, m.p. 214-15° C, whose NMR spectrum in $CDCl_3$ resembled that of taxifolin tetramethyl ether but had a three proton singlet at δ 2·08 for an aromatic $C-CH_3$ group and a one-proton singlet at δ 6·30 belonging to A ring. The mass spectrum of the methyl ether confirmed the presence of a $C-CH_3$ group in the A ring (m/e: 374 (M^{+}), 207 and 195 (100%). Compound B formed a penta-acetate, m.p. 145°C, whose NMR spectrum in $CDCl_3$ again confirmed the presence of a $C-CH_3$ group in the A ring. The location of the C-methyl group in the 8-position has been determined by dehydrogenation with I_2/KOAc in glacial acetic acid[2] whereby a C-methyl flavonol $C_{16}H_{12}O_7$, m.p. 290-95° C was obtained. It differed from pinoquercetin (6-methyl quercetin)[3]. Its pentamethyl ether $C_{21}H_{22}O_7$ (M^{+} 386), m.p. 220-21° C was identical with synthetic 8-C-methyl quercetin pentamethyl ether[4] in all respects (m.m.p., TLC and IR). C-Methyl dihydroflavonols are rare; only quite recently 6-C-methyltaxifolin was reported to occur in *Populus deltoides*.[5]

Two more compounds, C and D were obtained from the polyamide column. Compound C, m.p. > 300° C, was found to be a flavonol and was identified as quercetin. Compound D was difficult to separate from compound C. It was also a flavonol comparing with 8-C-methyl quercetin on TLC. That these two compounds are not artefacts was proved by the fact that a fresh extract showed their presence on TLC examination.

Consequent on the above findings, the name 'deodarin' may now be applied to 8-C-methyl 3′, 4′, 5, 7-tetrahydroxy dihydroflavonol.

Our thanks are due to Prof. K. Venkataraman for a sample of pinoquercetin and the Council of Scientific and Industrial Research for a Research Fellowship to K. R.

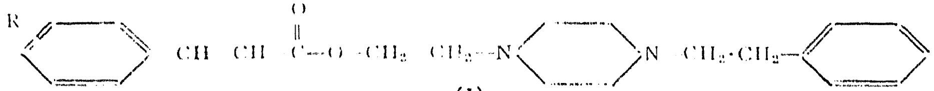
Dept. of Chemistry, K. RAGHUNATHAN.
Delhi University, S. RANGASWAMI.
Delhi-7, *July* 22, 1971. T. R. SESHADRI.

---

1. Adinarayana, D. and Seshadri, T. R., *Tetrahedron*, 1965, **21**, 3127.
2. Mahesh, V. B. and Seshadri, T. R., *Proc. Indian Acad Sci.*, 1955, **41 A**, 210.
3. Kurth, E. F., Ramanathan V. and Venkataraman, K., *J. Sci. Ind. Res.* (India), 1956, **15 B** 139.
4. Jain, A. C. and Seshadri, T. R., *Ibid.*, 1953, **12 B**, 564.
5. Pearl, I. A. and Darling, S. F., *Canad. J. Chem.*, 1971, **49**, 49.

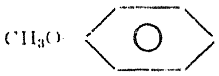
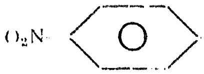
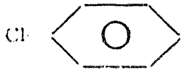
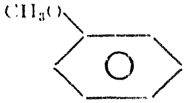
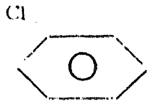
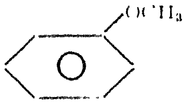
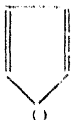
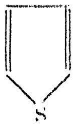
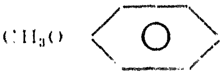
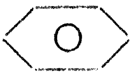
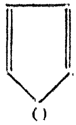
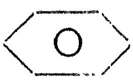
SYNTHESIS OF PIPERAZINE ETHANOL ACRYLATES AS POSSIBLE ANTIPHLOGISTICS AND ANALGESICS

RECENT investigations by Elde Crescenzi and others[1] have shown that asymmetrical aryl piperazines mono acrylates are good anti-inflammatory compounds with analgesic and antipyretic activities. Some of them are antispasmodics also. In analgesics, especially, in the pyrrolidine group, it has been shown that the potency is very much enhanced if the nitrogen is substituted by the phenyl ethyl grouping.[2] In general, many of the ring-substituted cinnamic acids and esters have shown anti-inflammatory properties.[3,4] A survey of literature has revealed that an introduction of a phenyl ethyl grouping on the nitrogen of piperazine ethanol moiety followed by the esterification with the substituted cinnamic acids have not been synthesized and examined for their pharmacological properties. In the present work, an attempt was made to synthesise a few of the compounds having the basic skeleton (I) incorporating the above features, where R is OCH_3; NO_2; Cl; etc.



(I)

TABLE I

	R	R′	M.P.	Theory N%	Found N%	Analgesic	Antiinflammatory
(1)		H	213–15 (d)	5·2	5·0	–	–
(2)		H	255–58 (d)	8·7	8·3	+	–
(3)		H	228–30 (d)	5·9	5·8	±	–
(4)		H	228–30 (d)	6·0	6·2	–	–
(5)		H	232–35 (d)	5·9	5·8	–	–
(6)		H	182–185	6·0	6·5	±	–
(7)		H	228–31 (d)	6·5	6·7	±	–
(8)		H	240–43 (d)	6·3	6·3	±	–
(9)			210–213 (d)	5·2	5·0	+	±
(10)			227–230	5·6	5·4	..	..

(+) Means equal to aspirin; (–) No activity; (±) Nearly equal to aspirin.

In the cinnamic acid part, the phenyl group has also been replaced with furan and thiophene ring systems. The possible use of bis-phenyl ethyl piperazines as anthelminthic agents against *Haemonchus contortus* larvae was reported by Arundel and others.[5] In the present work, the compounds were screened for antiparasitic activity against the models *Namatospiroides dubius*, *Hymenolepis nana*, and *Syphacia obvelata* in laboratory mice. No significant activity could be detected on these experimental models.

In a typical experiment piperazine ethanol (0·2 mole) was condensed with phenyl ethyl bromide (0·2 mole) in the presence of anhydrous potassium carbonate (0·3 mole) using dry ethanol as solvent under reflux to give the phenyl ethyl substituted piperazine ethanol derivatives. The base (0·01 mole) was then condensed with the substituted cinnamoyl chloride (0·01 mole) in dry benzene in the presence of anhydrous sodium bicarbonate (0·04 mole) and refluxing the solution for 8 hours. The free base was isolated from the benzene, as the soluble hydrochloride by extracting it with aqueous hydrochloric acid. Basification of the aqueous solution with sodium hydroxide (10%) followed by benzene extraction and re-precipitating the hydrochloride by passing dry HCl gas into the benzene solution. All the hydrochlorides were recrystallised from ethanol. Table I (*see* p. 465) gives the details of the various compounds prepared together with their m.ps. and nitrogen analysis and their activities.

Compound Nos. 2, 8 and 9 showed analgesic potency equal to aspirin; compound Nos. 3, 6 and 7 had analgesic potency slightly lower than that of aspirin. Compound No. 9 showed anti-inflammatory potency slightly less than that of aspirin.

We thank Dr. V. Srinivasan, Research Director, Sarabhai Research Centre, Baroda, for his encouragement and useful suggestions and the pharmacology and parasitology sections for the screening results.

Dept. of Chemistry, J. D. RAMANATHAN.
Sarabhai Research Centre, Y. K. JANI.
Wadi Wadi, Baroda-7,
May 24, 1971.

---

1. Crescenzi, E., Marazi-Uberti, E. and Coppi, G., *J. Phrrm. Sci.*, 1966, **55**, 290.
2. Weijlard, J., *J.A.C.S.*, 1956, **78**, 2342.
3. Whitehouse, M. W., *Proc. Drug. Res.*, 1965, **8**, 375.
4. Lee, E. B. Shin, K. H. and Woo, W. S., *J. Med. Chem.*, 1968, **11**, 1262.
5. Arundel, J. H., Somers, T. C. and Handley, G. J., *Ibid.*, 1966, **9**, 556.

A NOTE ON THE ORDOVICIAN FOSSILS FROM THE BARAMULA DISTRICT, KASHMIR

THE object of the present note is to place on record the occurrence of a few articulate brachiopods from the Ordovician rocks exposed near Marhaum (34° 34′ : 34° 10′) in the Hundwara basin of Baramula District, Kashmir. These are in addition to the forms already described.[1-3]

During the course of recent investigations, the author made a huge collection of fossils, out of which the following forms have for the present been identified:

Orthis (*Eridorthis*) cf. *kalavensis* Reed.
Orthis (*Dalmanella*) cf. *emancipata* Reed.
Orthis ? sp.
Leptelloidea cf. *leptelloides* (Bekker).
Leptaena sp.
Leptaena rhomboidalis Wilck.
Sowerbyella wilsoni Reed.
Rafinesquina spp.
Strophomena sp.
Ahtiella ? sp.
Resserella sp.
Raymondella sp.

The presence of the species of *Resserella* and *Raymondella* with European affinities is important from stratigraphical point of view in that it will help in demarcating the boundary between Upper Ordovician and Lower to Middle Ordovician.

Resserella sp. in the present collection is affined to *Resserella* (*Howellites*) *striata* Bancroft recorded by Bancroft[4] from the Upper Ordovician rocks of Europe. *Raymondella* sp. has also close similarities to *Raymondella typa* Bancroft of the Upper Ordovician horizons of Europe. Rest of the forms, listed above, are long-ranging and occur throughout the Ordovician rocks in the present area.

Centre of Advanced Study I. J. SUNEJA.
in Geology,
Panjab University,
Chandigarh-14, *April* 16, 1971.

---

1. Wadia, D. N., "The Cambrian-Trias sequence of North-Western Kashmir (Parts of Muzaffarabad and Baramula Districts)," *Rec. Geol. Surv. Ind.*, 1934, **68**.
2. Reed, F. R. C., "Cambrian and Ordovician fossils from Kashmir, " *Pal. Ind. Geol. Surv. Ind.*, 1934, **21**.
3. Suneja, I. J., "Lower palaeozoic fossils from the Baramula District, Kashmir" (in press).
4. Bancroft, B. B., "The brachiopod zonal indices of the stages costonian to onion in Britain," *Jour. Pal.*, 1945, **19**.

X-RAY DIFFRACTION AND ELECTRONMICROSCOPIC STUDIES ON THE FINE STRUCTURE OF THE TRACHEAE OF A CENTIPEDE *SCUTIGERA LONGICORNIS*, TOGETHER WITH OBSERVATIONS ON THEIR CHEMICAL COMPOSITION

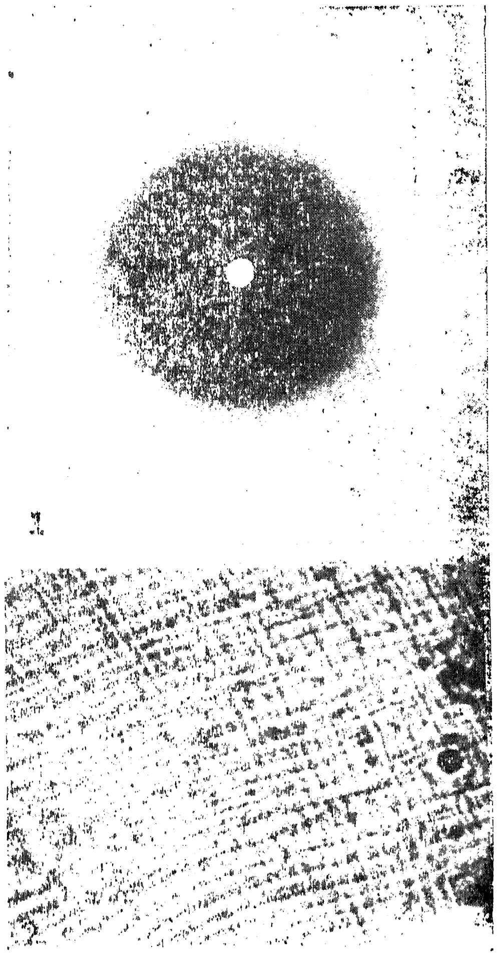
IT is well known that in Onychophora, Myriapoda and Insecta, respiration takes place by means of internal air-tubes, the tracheae.[1] The wall of the tracheae has spirally coiled chitinous intima which keeps the tracheae distended and prevents it from collapsing, to ensure free passage of air.[2] There is no diffusion of gases across the wall of tracheae, as blood in these arthropods does not take part in respiration.[3] An exception to this is found in scutigeromorph centipedes where the tracheae do not have chitinous intima, but are still distended and non-collapsible[4]; there is diffusion of gases across the wall of tracheae as blood in these myriapods contains haemocyanin and takes part in respiration.[5] But no attempt has so far been made to study the fine structure and chemical composition of the tracheae in Scutigeromorpha in relation to their exceptional properties; hence, the present investigation.

The material used was scutigeromorph centipedes of the species *Scutigera longicornis*, which is available in plenty in the humid regions of the Alagarkoil forest near Madurai. They were collected, brought to the laboratory and maintained as detailed elsewhere.[6]

For X-ray diffraction studies, tracheae isolated from freshly decapitated animals were washed thoroughly in distilled water, stretched, dried and stacked to give a final thickness of about 0·1 mm. CuKα radiation was used at a specimen to film distance of 4 cm. For electron-microscopic studies, freshly isolated and thoroughly washed tracheae were taken onto formvar-coated glass screens and dried in air at 20-25° C. Such preparations were shadow-cast with palladium and examined with RCA EMU-2 electronmicroscope.

The procedure adopted for the extraction of protein was based on the work of Hackman[7] and the method of quantitative estimations of individual amino-acids has been given elsewhere.[8] Details of histochemical techniques employed are given in appropriate contexts.

The X-ray diffraction diagram obtained for the tracheae of *S. longicornis* (Fig. 1) reveals a diffuse scattering in the central region and 2·9 Å meridional spacing. This would suggest that chitin is absent in the tracheae. If chitin is present, one would expect rings at 10·3 Å, 4·6 Å and 3·4 Å.[9] On the other hand, the 2·9 Å meridional spacing would indicate the presence of collagen.[10] Diffuse scattering in the central region of the diagram obscures other features of X-ray wide angle diagram. Possibly, in the native state the fibrils of collagen are in perpendicular layers and only those fibrils which are parallel to the stretch become oriented, which results in the appearance of the meridional arc.



FIGS. 1–2. Fig. 1. X-ray diffraction diagram of stretched trachea of *Scutigera longicornis*, recorded with CuKα radiation. Fig. 2. Tracheal wall of *Scutigera longicornis*. Shadow cast with palladium, × 45,000.

Electronmicroscopic examinations of the tracheae lend support for this suggestion. Figure 2 presents an electronmicrograph of tracheae of *S. longicornis*; it disclosed that the wall of the tracheae has a network consisting of two systems of transverse and longitudinal fibrils, disposed in regular order at right angles delimiting square cells. The fibrils are all of uniform diameter measuring 4 to 6 millimicrons. The square regions in between the fibrils seem to be thin homogeneous membranes.

TABLE I

Amino-acid composition of the protein extracted from the tracheae of Scutigera longicornis *in residues amino-acid*/1000 *total residues (amide value omitted)*

No.	Amino-acids		Amonnt
1	Alanine	..	112·0
2	Arginine	..	39·8
3	Aspartic acid	..	55·6
4	Glutamic acid	..	71·0
5	Glycine	..	335·7
6	Hydroxylysine	..	..
7	Hydroxyproline	..	68·4
8	Leucine	..	29·0
9	Lysine	..	28·6
10	Histidine	..	12·9
11	Isoleucine	..	15·0
12	Methionine	..	15·2
13	Phenylalanine	..	0·9
14	Proline	..	83·4
15	Serine	..	68·9
16	Threonine	..	45·7
17	Tyrosine	..	1·9
18	Valine	..	23·3

Collagen from different sources differs markedly in its amino-acid composition, although all give the characteristic collagen X-ray diagram. However, the presence of glycine, hydroxyproline and proline in large quantities is considered characteristic of collagen.[11] The protein extracted from the tracheae was hydrolysed and subjected to quantitative estimations of individual amino-acids. The results are given in Table I which may show that glycine forms about one-third of the total amount of amino-acids; hydroxyproline and proline are also found in larger amounts. A notable feature is the absence of hydroxylysine which recalls the condition noted in annelid collagen.[12]

In addition to collagen, the tracheae of *S. longicornis* react positively to tests for acid mucopolysaccharides. Sections of tracheae stained deep blue with alcian blue and red with toluidine blue. The metachromasia with toluidine blue may indicate the presence of highly acidic mucopolysaccharide. The metachromasia was not removed by washing with 95% ethanol indicating presence of esters of sulphuric acid.[13] Methylene blue stained the tracheae at pH 2·6 and the extinction point lies between pH 1·0 and pH 1·4 and the capacity to bind methylene blue below pH 4·0 is considered indicative of presence of sulphate groups. These observations may suggest that the trachea of *S. longicornis* contains sulphated acid mucopolysachharides.

The roles of collagen and acid mucopolysaccharides have been discussed by several workers.[14] An important function of collagen is its role as a skeletal structure especially in instances where chitin is absent.[15] Acid mucopolysaccharides present in the respiratory tubes of vertebrates are said to make them permeable to respiratory gases.[14] In the light of these observations, it is suggested that in the absence of chitinous intima, collagen fibrils may act as skeletal structure in the tracheae and acid mucopolysaccharides may render the wall of the tracheae permeable to respiratory gases in *Scutigera longicornis*.

Thanks are due to Dr. G. Krishnan for helpful suggestions. I am indebted to Dr. N. Krishnan, Development Biology Centre, Western Reserve University, Ohio, U.S.A., for preparing electronmicrographs, and to my colleagues in the Physics Department for help in taking X-ray photographs.

Dept. of Zoology, G. SUNDARA RAJULU.
University of Madras,
Madras, *July* 26, 1971.

---

1. Tiegs, O. W. and Manton, S. M., *Biol. Rev.*, 1958, **33**, 255.
2. Richards, A. G. and Korda, F. H., *Ann. Ent. Soc. Amer.*, 1950, **43**, 49.
3. Wigglesworth, V. B, *Biol. Rev.*, 1931, **6**, 181.
4. Lawrence, R. F.. *The Biology of Ctyptic Fauna of Forests*, Balkema, South Africa, 1953.
5. Sundara Rajulu, G., *Curr. Sci.*, 1969, **38**, 168.
6. —, *J. Anim. Morph. Physiol.*. 1966, **13**, 114.
7. Hackman, R. H.. *Biochem. J.*, 1953, **54**, 362.
8. Sundara Rajulu, G., *Comp. Biochem. Physiol.*, 1970, **37**, 339.
9. Meyer, K. H. and Pankow, G. W., *Helv. Chim. Acta*, 1935, **20**, 353.
10. Austbury, W. T., *Trans. Faraday Soc.*, 1938, **34**, 378.
11. Gross, J. and Piez, K. A., *Calcification in Biological Systems*, AAA, Washington, 1960.
12. Watson, M. R. and Sylvester, N. R., *Biochem. J.*, 1959. **71**, 578.
13. Kramer, H. and Windrum, G. M., *J. Histochem. Cytochem.*, 1954, **2**, 196.
14. West, E. S. and Todd, W. R., *Text-Book of Biochemistry*, Macmillan Co., New York, 1957.
15. Rudall, K. M., *Symp. Soc. Exper. Biol.*, 1955, **1**, 168.

A NOTE ON THE EFFECT OF OXYGEN TENSION ON RESPIRATION IN *RANA TIGRINA*

METABOLIC rates in salamanders[1] are known to be dependent upon the oxygen tension in air, and oxygen concentration in water has been found to modify the oxygen consumption and heart rates in several amphibians submerged in water.[2]

The oxygen consumption of the frog, *Rana tigrina*, placed in different atmospheres of oxygen-nitrogen mixtures[3] was measured at 30° C by simple pressure-sensitive respirometers as described by Dwarakanath.[4] The respirometers contained 10 ml of water in which the frogs were placed. Two ml of 20% potassium hydroxide was used as carbon dioxide absorbent.

The oxygen consumption of *R. tigrina* increased 43% from 10% oxygen to an atmosphere of air (21% oxygen) as shown in Fig. 1.

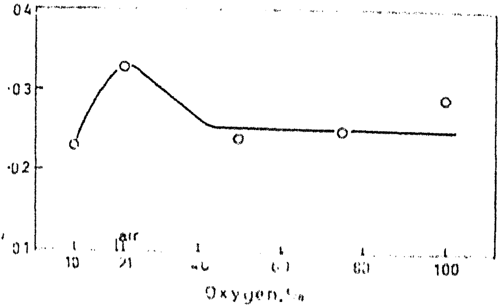


FIG. 1. Effect of oxygen tension on oxygen uptake in *R. tigrina* at 30° C. Each dot represents the average value of oxygen consumption of 4–6 animals.

The rates decreased in an atmosphere of 50% oxygen compared to that in air and a similar trend has also been observed in salamanders.[1] The rates showed little change in an atmosphere of 50% and 75% oxygen though a slight increase was observed in 100% oxygen. *R. tigrina* could not tolerate pure oxygen for 3 hours since some of them died on the day next to the experiment though *R. esculenta*[5] could survive for 52 days in an atmosphere of pure oxygen.

I wish to thank Prof. S. Krishnaswamy for guidance and the Madurai University for the award of a Fellowship.

Dept. of Biology, J. C. B. ABRAHAM.
Madurai University,
Madurai-2, *April* 27, 1971.

---

1. Norris, W. E., Grandy, P. A. and Davies, W. K., *Biol. Bull.*, 1963, **125**, 523.
2. Jones, D. R., *Comp. Biochem. Physiol.*, 1967, **20**, 691.
3. Umbreit, W. W., Burris, R. H. and Stauffer, J. F., *Manometric Techniques*, Burgess, Minneapolis, 1959.
4. Dwarakanath, S. K., *Comp. Biochem. Physiol.*, 1971, **38**, 351.
5. Binet, L. and Bochet, M., *J. Physiol.*, 1963, **55**, 405.

FREE AMINO-ACID CONTENT OF THE GREENING AFFECTED AND HEALTHY PLANTS OF SWEET ORANGE (*CITRUS SINENSIS* OSBECK)

THE present investigation was carried out to study the free amino-acid content of the greening-affected and the healthy plants of sweet orange in order to get a possible explanation as to why the various fungi, *e.g.*, *Colletotrichum gloeosporioides*, *Curvularia tuberculata* and *Diplodia natalensis*,[2,3] were found to be more virulent on greening affected plants than on the healthy ones.

The analysis of the free amino-acids was done by ascending paper chromatography using standard amino-acids as control.[1] Five grams of fresh tissue (leaves) from healthy as well as greening-affected plants of same age were incubated at 25 ± 1° C. The leaves were air-dried, powdered and extracted twice with 80% hot ethanol. The extract was filtered and evaporated to dryness on a water-bath. The residue was dissolved in 1 ml of *n*-butanol. The extract was applied on Whatman No. 1 filter-paper (28 × 28 cm) and a mixture of *n*-butanol : acetic acid and water (4 1 : 5 v/v) was used as the running solvent. Chromatograms were developed after 14 hr, by spraying with 0·2% ninhydrin (indane-trione hydrate) in *n*-butanol to detect various amino-acids. Sprayed chromatograms were allowed to dry and subsequently they were heated in an electric oven at 110° C for 15 min. Identification of various amino-acids was established by chromatography of the standard at known concentrations. Qualitative differences were determined on the basis of visual observation of the colour intensities and size of ninhydrin positive spots. The signs + and — are the indications of the presence or absence of particular amino-acid. The number of +ve signs denote the intensities of the individual amino-acid. The number of + sign is not comparable between different amino-acids (see Table I).

2·0 mm in diam. postea. Mycelium partim superficiale vel partim immersum. Hyphae superficiale septatae, olivaceo-brunneae, 1·6-3·2 μ latae, ad muri levia. Conidiophora simplicis, brevia, septata, annellata 1-6 multitudinis ad apicem, 3·2-6·4 μ lata, oriunda terminale vel lateralis ex hyphis. Conidia acrogena, variabilia, ovata vel clavata vel cylindrica, fusce-brunnea, dictyosporas, levia, plerumque ad 3-5 septa transversalibus vel 6-10 septa rarius, septa longitudinalibus 0-4, 12-45 μ longa vel 74·6 μ rarius, 8-13 μ lata ad maximus.

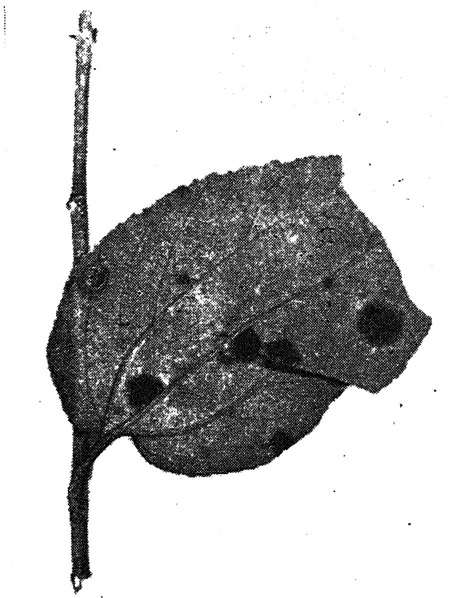


FIG. 1. Hypophyllous spots on *Zizyphus oenoplia.*

In foliis viventibus *Zizyphus oenoplia* Mill. (Rhamnaceae), a C. M. Chary ad Vikarabad (A.P.) India, ad die 24, mensis decembris anni 1968. Typus lectus et pisitus in Herb. Orientalis ad Osmania universidas sub numero 178. Isotype et positus in C.M.I., sub numero 138950.

Annellophorella zizyphi sp. nov. *Manohara Chary and Ramarao*

Infection spots hypophyllous, dark olive-brown, effuse, often occupying large areas; early infection spots 0·2 to 0·6 mm, later becoming 2·0 mm or more in diameter. Mycelium partly superficial and partly immersed; hyphae septate, pale brown, smooth, 1·6-3·2 μ broad, superficial hyphae upto 4·8 μ thick; conidiophores arising laterally or terminally on the hyphae, simple, short, often septate, with 1-6 annellations towards the apex, upto 3·2-6·4 μ thick; conidia acrogenous, often proliferating after the first conidium falls, variable in shape, ovate to clavate or cylindrical, dark brown, thick-walled, smooth, dictyosporous, usually with 3 to 5, rarely 6 or upto 10 transverse septa and 0-4 longitudinal septa, basal cell crucible-shaped, light brown, conidia measuring 12-45 μ or rarely upto 74·6 μ in length and 8-13 μ thick at the broadest part.

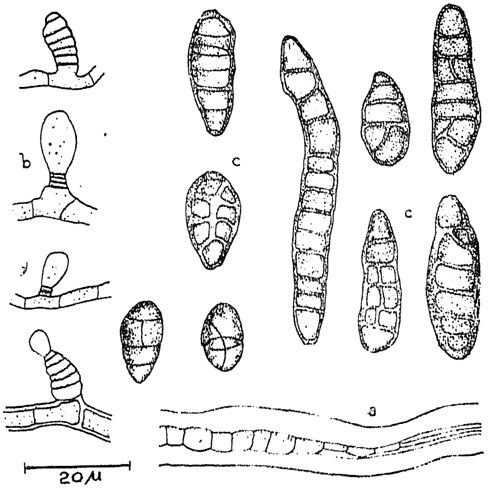


FIG. 2. *Annellophorella zizyphi.* (*a*) Mycelium in the lumen of an epidermal hair. (*b*) Conidiophores. (*c*) Conidia.

Hab. On the living leaves of *Zizyphus oenoplia* Mill. (Rhamnaceae), C. M. Chary, 24-12-1968, Vikarabad (A.P.), India; Osmania University, Hyderabad Herb. 178 type; C.M.I. 138950 isotype.

The authors wish to express their grateful thanks to Dr. Ellis, C.M.I., Kew, for help in the identification of the fungus, to Dr. M. R. Saxena for kind encouragement and to Dr. P. Raghuveer Rao for the Latin diagnosis.

Mycol. and Plant Path. Lab., CH. MANOHARA CHARY.
P. RAMARAO.
Dept. of Botany,
Osmania University,
Hyderabad-7 (A.P.), *April* 27, 1971.

---

1. Sydow, H., *Ann. Mycol. Berl.*, 1912, **10**, 444.
2. Subramanian, C. V., *Proc. Indian Acad. Sci.*, 1962, **55 B**, 6.
3. Ellis, M. B., *Mycol. pap.*, **87**, 11.
4. Hennings, P. C., in *H. Baum's Kurene-Sambesi Expedition*, *Berlin*, 1903, p. 169.

REVIEWS AND NOTICES OF BOOKS

Physics of Hot Plasmas. Edited by B. J. Rye and J. C. Taylor. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011, U.S.A.), Pp. 455. Price $ 32.50.

This volume, the ninth in the series, contains the papers presented to the Scottish Universities' Summer School in Physics in 1968 by eminent pioneers in Plasma Physics research. This is the first to be devoted to Plasma Physics by the School.

The volume opens with an introduction to the kinetic theory of plasmas by W. B. Thomson prepared in such a lucid way that it can serve a beginner as well as a research worker in the field. Both macroscopic and microscopic points of view of plasma physics have been considered, and the discussion includes waves, instabilities, turbulence and collisionless shocks. The volume also serves to give a better understanding on recent advances in controlled thermonuclear problems. Some of the discussions on different topics are new and interesting. A good lot of references to original literature at the end of each chapter add to the usefulness of the book.

S. NARASIMHA MURTHY.

Applied Solid-State Physics. Edited by W. Low and M. Schieber. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011, U.S.A.), 1970: Pp: vii + 244. Price $ 13.50.

The papers presented in this volume are edited versions of lectures given at the Bathsheva de Rothschild Seminar on Applied Physics held at the Hebrew University of Jerusalem, Israel, April 21–May 14, 1968.

The lectures were delivered by experts engaged in their respective fields. The contents are as follows: Parametric Optics, by J. A. Giordmaine; Holography and Its Applications, by Albert A. Friesem; Light Scattering with Laser Sources, by S. P. S. Porto; Vision: Human and Electronic, by A. Rose; Principles of Solidification, by B. Chalmers; Techniques of Crystal Growth, by R. A. Laudise; Empirical Approach to Superconductivity, by B. T. Matthias; Material Aspects of Computer Storage, by W. D. Doyle; and Semiconductor Photovoltaic Effect and Devices, by Morton B. Prince.

Dr. Giordmaine discusses in the first paper three examples of parametric field interactions which have assumed importance in recent optical studies, namely, optical parametric oscillation, parametric fluorescence, and the stimulated Raman Effect. Dr. Friesem presents the basic principles of holography and its potential uses, and includes in the presentation hologram interferometry, pulse laser holography and ultrasonic holography. Dr. Porto gives in his short paper a bird's eye view of what is going on today in the field of light scattering with laser sources, with emphasis on Raman Effect.

The chapter on vision by Dr. A. Rose is the major content occupying nearly a third of the book, and it is a definitive review on human and electronic vision, which has been his lifelong activity. Dr. Rose brings in juxtaposition the material contained in several published papers dealing with how well the human system succeeds as a photon counter and how well various electronic devices can be designed as photon counters.

Dr. Chalmers and Dr. Laudise lectures are concerned with crystals, the former dealing with the theoretical aspect and the latter with the practical aspect of crystal growth.

The last three articles are in the field of materials science and are concerned with the theoretical and applied aspects of superconductivity and with photovoltaic effect.

This publication will be of particular help to both specialists in applied physics, chemistry and engineering and also to graduate students of solid-state physics and electrical engineering.

A. S. G.

Progress in Mathematics. Edited by R. V. Gamkrelidze. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011, U.S.A.). Volume 8: *Mathematical Analysis*. Pp. 215. Price $ 15.00; Volume 9: *Algebra and Geometry*. Pp. 253. Price $ 19.50.

The volumes in this series are English translations of original Russian texts. They are review articles on topics of current interest in mathematical research. The articles are written for readers who may not be experts in the areas covered. The exposition is systematic and detailed, and important results are given in full wherever possible. References to literature are exhaustive.

Volume 8 contains three articles: "Asymptotic Methods in the Theory of Ordinary Differential Equations" surveys the literature on linear and non-linear, asymptotic problems, the survey covering the period 1962-67. "The Theory of Best Approximation in Normal Linear Spaces" is devoted to the problem of existence, characterization, and uniqueness of best approximations in Banach spaces. The survey covers the literature of the decade 1958-67. The third article "Dynamical Systems with Invariant Measure" is a rapidly growing branch of mathematics and a survey of the topics on entropy theory, classical dynamic systems, ergodic theorems, algebraic and numeric-theoretic extraction, etc., covering the period 1956-67, is given.

Volume 9 contains five review articles, two in the Algebra part and three in the Geometry part surveying the fields of categories and class field theory, in the first part, and of Finsler spaces, structures on differential manifolds and packing, covering, etc., in the second part. The literature covers the publications during 1964-67. A. S. G.

Introduction to the Theory of Solid-State Physics. By James D. Patterson. (Published by Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London W. 1, England), 1971. Pp. x + 388. Price 135 *sh.*

This book is intended as a text-book for a course on solid-state physics to graduate students. The prerequisites are courses on quantum mechanics and introductory solid-state physics.

The emphasis is on providing a thorough treatment of the fundamental aspects of the subject. Thus, there is a greater degree of mathematical exposition than is usual in text-books of this kind. The first five chapters forming the bulk of the book respectively deal with (*i*) elements of group theory and crystal structure, (*ii*) lattice vibrations and thermal properties of matter, (*iii*) electrons in periodic potentials, (*iv*) magnetism, magnons, and magnetic resonance, and (*v*) interaction of electrons and lattice vibrations. The sixth and last chapter entitled, "A Potpourri of Solid-State Topics" is devoted to brief discussions of a variety of topics as metals and the Fermi surface, semiconductors, optical properties of solids, defects in solids, dielectric properties of solids, and superconductivity.

At the end of each chapter are included problems and references for supplementary reading. A. S. G.

Pulsating Stars, Vol. 2. (A *Nature* Reprint.) (Published by Plenum Publishing Corporation, 227, West 17th Street, New York, N.Y. 10011, U.S.A.), 1969. Pp. xii + 116. Price $ 12.00.

The discovery of pulsating radio sources or the pulsars in 1967 by the Cambridge radio astronomers has added an exciting new chapter to astronomical research. The first announcement was followed by immediate observational work by the radio astronomical observatories of the world, and theoretical debates by cosmologists concerned with the origin and evolution of the universe. Papers flowed in large numbers. *Nature* formed the main forum for the publication of results, discussions, and theoretical explanations and conjectures in this field of pulsar astronomy. A collection of these papers from time to time will be a useful reference work for radio astronomers.

The first volume contained 51 papers on the subject published in *Nature* from the start of the first paper in 1967 to the autumn of 1968. The present volume is a continued collection of 64 papers which appeared in *Nature* in 1968 and 1969. They are arranged under the main heads: (1) PSR 0833-45 and NP 0532: The Fast Pulsars; (2) Distributions and Distances; (3) Theories; and (4) Observations: Radio, Optical, Gamma-ray, X-ray. Professor T. Gold, Director of the Center of Radiophysics and Space Research, Cornell University, has provided the Introduction. A. S. G.

Tables of Spectral Lines. Compiled by A. N. Zaidel *et al.* (IFI/Plenum Data Corporation, 227, West 17th Street, New York, N.Y. 10011), 1970. Pp. 782. Price $ 50.40.

Tables of Spectral Lines, as basic primary material for the identification of spectra, are indispensable for working spectroscopists. Naturally, with the availability of improved techniques and methods of measurements, these tables require revision and updating.

The Russian work underlying this English translation is the third revised edition published in Moscow in 1969. A special feature of this compilation is that it contains fairly complete lists of the spectral lines of the more important elements but at the same time it is not overloaded with an abundance of weak lines, especially of relatively unabundant elements. This judicious selection makes the use of the tables less difficult. Thus, the basic tabular material contains about 52,000 wavelengths as against 109,000 in Harrison's tables which are the most complete and which served as the starting material of the present book.

The book is in three parts. Part I of 350 pages presents about 52,000 lines in order of decreasing wavelength. Lines are given for 60 elements of practical importance. It includes also the edges of the intense molecular bands usually appearing in the spectra. Part II of 400 pages lists about 38,000 lines according to elements (in alphabetical order). Besides wavelength, the intensity and excitation potential are also given against each line. Part III, though of 30 pages only, gives a variety of useful auxiliary reference material such as sensitivity lines, wavelength standards of Fe and rare gases, oscillator strengths, λ_{vacuum} λ_{air} corrections, ionization potentials, m.p.'s and b.p's of elements and their oxides, etc.

Thus the book gives in a convenient form, fairly completely, all reference material required for the everyday work of spectrochemical analysts and atomic emission spectroscopists. A. S. G.

ANNOUNCEMENTS

Symposia on "Defect Interactions in Solids" and "Industrial Metallurgy"

On the occasion of the Silver Jubilee Celebrations of the Department of Metallurgy, Indian Institute of Science, Bangalore, there will be held two Symposia from 9-13 May, 1972.

The symposium on "Defect Interactions in Solids" is aimed at a critical appraisal, analysis and evaluation of recent theoretical and experimental investigations involving interactions of point defects, dislocations and other defects. Papers based on original research in the following groups are invited for presentation and discussion: Group I—Point Defect Interactions; Group II—Dislocation Interactions.

The Symposium on "Industrial Metallurgy" aims at linking the science of metals to the metal industries. Papers based on original research, experience, or shop studies in modern developments in the following and allied areas are invited for presentation and discussion:

Casting Techniques; Joining Techniques; Forming Techniques; Treatments; Testing and Analysis; and Special Metals and Alloys.

In order to facilitate the publication of the proceedings, the Editorial Committee has set the following schedule: Submission of extended abstracts: October/November 1971; Submission of full text of paper: January 1972 (Ca. 10 pages, two copies).

For further information please address: Dr. K. I. Vasu, Symposium Convener, Department of Metallurgy, Indian Institute of Science, Bangalore-12.

Symposium on Estuarine Biology

The Second All-India Symposium on Estuarine Biology is proposed to be held at the Centre of Advanced Study in Marine Biology, Porto Novo, from 20th to 24th January, 1972. Contributions are invited from intending participants in the following fields: (*a*) Hydrobiology of estuaries and backwaters; (*b*) Biology of estuarine animal communities; (*c*) Estuarine ecology and pollution; (*d*) Physiology and biochemistry of estuarine organisms; (*e*) Estuarine productivity food and fisheries; and (*f*) Estuarine microbiology.

Provisional titles of papers should reach the organisers before 1st October, 1971, and the abstract of the paper, before 30th November, 1971.

For further information contact: Dr. R. Natarajan, Centre of Advanced Study in Marine Biology, Porto Novo, Tamil Nadu.

Books Received

Problems in Mathematical Analysis (Vol. 2)—*Linear Operators and Operator Equations.* Edited by Acad. V. I. Smirnov. (Plenum Pub-Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1971. Pp. v + 129. Price $ 16.00:

Quantum Electronics and Paramagnetic Resonance. By Acad. D. V. Skobel'tsyn (Plenum Pub. Corpn., New York), 1971. Pp. vii + 148. Price $ 20.00.

Radio Astronomy Instruments and Observations. By Acad. D. V. Skobel'tsyn. (Plenum Pub-Corpn., New York), 1971. Pp. viii + 184. Price $ 30.00.

Rock Weathering. By Dorothy Carroll. (Plenum Publishing Corpn., 114, Fifth Avenue, New York 10011), 1970. Pp. xv + 203. Price $ 15.00.

3007-71. **Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.**

Newly Published Volumes from...................... **ANNUAL REVIEWS INC. a nonprofit corporation**

ANNUAL REVIEW OF BIOCHEMISTRY Volume 40

Editors : E. E. SNELL, P. D. BOYER, A. MEISTER, R. L. SINSHEIMER

July 1971/ 1206 pages/ $ 13.00 (USA) and $13.50 (elsewhere), postpaid.

CONTENTS

Some Personal History and Reflections from the Life of a Biochemist, *J. T. Edsall.* Complex Polysaccharides, *E. C. Heath.* Sphingolipids, *W. Stoffel.* Long-Range Nonradiative Transfer of Electronic Excitation Energy in Proteins and Polypeptides, *I. Z. Steinberg.* Oxidation and Energy Conservation by Mitochondria, *K. van Dam and A. J. Meyer.* Chloroplast Structure and Biogenesis, *J. T. O. Kirk.* Photosynthesis : The Electron Transport System of Green Plants, *N. I. Bishop.* Spin-Label Studies of Co-operative Oxygen Binding to Hemoglobin, *H. M. McConnell.* Oscillatory Phenomena in Biochemistry, *B. Hess and* A. *Boiteux.* Affinity Chromatography, *P. Cuatrecasas and C. B. Anfinsen.* Histones : Structure and Function *R. J. DeLange and E. L. Smith.* Transients and Relaxation Kinetics of Enzyme Reactions, *H. Gutfreund.* Metabolic Regulation by Chemical Modification of Enzymes, *H. Holzer and W. Duntze.* Ultrastructural Localization of Enzymes, *T. K. Shnitka and A. M. Seligman.* Peptide Transport and Metabolism in Bacteria, *A. J. Sussman and C. Gilvarg.* Protein Biosynthesis, *J. Lucas-Lenard and F. Lipmann.* Biosynthesis of Peptide Antibiotics, *D. Perlman and M. Bodanszky.* Biochemistry of Catecholamines, *P. B. Molinoff and J. Axelrod.* Metabolic Role of Vitamins A and D, *R. H. Wasserman and R. A. Corradino.* Pheromones, *J. H. Law and F. E. Regnier.* Nutritional Methodology in Metabolic Research with Rats, *H. Greenfield and G. M. Briggs.* Clinical Biochemistry, *M. L. Moss, C. A. Horton and J. C. White.* Applications of Nuclear Magnetic Resonance Spectroscopy to the Study of Macromolecules, *O. Jardetzky and N. G. Wade-Jardetzky.* Proteins of the Nervous System, *E. M. Shooter and E. R. Einstein.* Protein-Protein Interaction and Enzymatic Activity, *C. Frieden.* RNA Polymerase, *R. R. Burgess.* The Biological Significance of Purine Salvage, *A. W. Murray.* Lysogeny : Viral Repression and Site-Specific Recombination, *H. Echols.* Cyclic AMP, *J. P. Jost and H. V. Rickenberg.* Regulation of Biosynthetic Pathways in Bacteria and Fungi, *J. M. Calvo and G. R. Fink.* Antibiotics and Nucleic Acid, *I. H. Goldberg and P. A. Friedman.* Inhibitors of Ribosome Functions, *S. Pestka.* Biosynthesis of DNA, *M. Goulian. Circular* DNA, *D. R. Helinski and D. B. Clewell.* Recent Results of tRNA, Research, *D. H. Gauss, F. von der Haar, A. Maelicke, and F. Cramer.* Antibody Diversity, *G. P. Smith, L. Hood, and W. M. Fitch.* Structure and Function of Proteins, *G. P. Hess and J. A. Rupley.* Insect Juvenile Hormone Analogues, *K. Slama.*

ANNUAL REVIEW OF MATERIAL SCIENCE Volume 1

Editors : R. A. HUGGINS, R. H. BUBE, R. W. ROBERTS

September 1971/ Approx. 412 pages/ $ 10.00 (USA) and $10.50 (elsewhere), postpaid

CONTENTS

Structural Characterization of Materials by Use of Electron Microscopy and Spectroscopy, *Victor A. Phillips and Eric Lifshin.* Development and Application of Theoretical Techniques to Problems in Materials Science, *John C. Phillips.* Anomalous Properties of the Vanadium Oxides, *J. B. Goodenough.* The Structure of Defects in Solids, *J. H. Crawford, Jr., and L. M. Slifkin.* Models of the Geometrical, Electronic, and Vibronic Structures of Ideal Clean Solid Surfaces, *C. B. Duke.* Solid-State Phase Transformations, *C. M. Wayman.* Solution Thermodynamics in Metallic and Ceramic Solid System, *C. B. Alcock.* Crystal Growth, *R. A. Laudise, J. R. Carruthers, and K. A. Jackson.* Solid Thin Films, *E. Kay.* Physics of Strengthening Mechanisms in Crystalline Solids, *William D. Nix and Ricardo A. Menezes.* Electronic and Optical Phenomena in Semiconductors, M. E. Jones and R. T. Bate. Corrosion Science, 1970 *David A. Vermilyea.*

All volumes are clothbound, with subject, author, and cumulative indexes. .Back volumes, reprints, quantity discounts, and student rates available. Information sent on request.

In preparation :

ANNUAL REVIEW OF ANTHROPOLOGY, Vol. 1, October 1972
ANNUAL REVIEW OF BIOPHYSICS AND BIOENGINEERING, Vol. 1, June 1972

ANNUAL REVIEWS INC. 4139 El Camino Way
Palo Alto, Calif. 94306 USA

CHOLERA RESEARCH - NEWER FACETS

DR. S. MUKERJEE, M.B., D.SC., F.N.A.

IT has been said that rediscoveries are a recurring feature of cholera research. There is a germ of truth in this, because since Koch's discovery of *Vibrio comma*, the research effort that has gone into the study of cholera has been tremendous and every aspect of its study has given rise to lively controversy at one time or another, with opposing viewpoints being canvassed with apparently weighty experimental support. An example which is timely because of the present interest in cholera toxin, is the controversy over Virchow's view that cholera is essentially a disease of intoxication. This point of view was largely forgotten during the first 60 years of this century till Prof. S. N. De's researches[1] pointed to the crucial role of cell-free vibrio products in cholera pathogenesis. Another example is the controversy that grew around the pathogenic capacity of the so-called non-agglutinable vibrios. It would seem that the 'rediscoveries' in the history of cholera research have been, by and large, the resurrection of old hypotheses from the extensive literature of cholera, prompted by new epidemiological or laboratory observations which could not be fitted in with extant views. This is no matter for surprise, when we consider the versatility of the cholera vibrio, its remarkable tendency towards variation and its hardihood in having survived in spite of improved sanitation and antibiotic therapy. Every time we think that we have at long last begun to contain the cholera vibrio, it reappears in a new form and spreads in pandemic form, as the ElTor vibrio did in the sixties at a time when the incidence of cholera had become limited to the Indo-Pakistan sub-continent for several years. In 1969, further evidence came of the pathological versatility of the cholera vibrio, with reports of cholera like cases due to NAG vibrios from East Pakistan[2], Czechoslovakia[3] and Sudan[4]. Partly because of this continuing epidemiological importance of the cholera vibrio and partly because of the intriguing scientific problems arising out of pathology of cholera, there has been a tremendous spurt in cholera research during the last few years and much new knowledge has been gathered. In this article I shall confine myself to newer facets of research on cholera bacteriology, epidemiology and immunology. The space will not allow me to touch on the important work that has been done in several laboratories in India and abroad on the purification and characterization of cholera enterotoxin, or on the biochemical lesions caused by the toxin; which is now considered to be primary factor in cholera pathogenesis. These aspects have been recently covered in a review by Burrows and Kaur[5].

TAXONOMIC CRITERIA OF THE GENUS *Vibrio*

The IAMS sub-committee on taxonomy of vibrios[6] recommended the following description as a provisional one for the genus *Vibrio*:

"Gram negative, asporogenous rods with a single rigid curved or straight rod; single polar flagellum; oxidase positive; produce acidity without gas from glucose; acidity from glucose is produced by the Embden Meyerhof glycolytic pathway." However, anaerogenic aeromonads and other related bacteria may be included in the genus *Vibrio*, so far as the recommendation is applied in routine diagnostic laboratories. The members of the taxonomic sub-committee recently agreed that the following extension should be added to the definition of the genus Vibrio. Lysine and ornithine decarboxylase positive; Arginine dehydrolase negative G-C ratio ranging from 40–50. *Aeromonas* can thus be excluded by being ornithine and lysine decarboxylase negative and arginine dehydrolase positive while *Plessiomonas* are positive to all these three tests.

The species *V. cholerae* is only specified by certain parameters. The ElTor vibrios being associated with classical vibrios at a high level of over 90% significance in the numerical classification and their G + C ratio being the same, are included in the species *V. cholerae*. On the same argument the so-called non-agglutinable vibrios (NAG) are also to be included into the same species *V. cholerae*.

Serotypes.—Sakazak *et al.*[7] have reported 39 serotypes of *V. cholerae* that includes the non-agglutinable vibrios also and the present studies indicate the possibilities of some more types to be identified amongst them. In the 0–1 serotype we recognize 3 sub-types or 0-forms Ogawa, Inaba and Hikojima. It has been observed by many scientists that Ogawa is the complete form and Inaba is a loss variant, Hikojima being the middle form. Till now much epidemiological importance was attached to these subtypes. But now-a-days it is known to be not of much value, because in an epidemic caused by Ogawa subtype some Inaba variants are frequently observed; the same phenomenon is also observed in the case of Hikojima subtype. It should therefore, be emphasized that not much importance should be put on these subtypes.

Phage-types.—In recent outbreaks it has been observed that new phage-types appear in very small numbers as a result of which we may get a few phage-type 5 strains of *V. cholerae* biotype ElTor in an outbreak caused by phage-type 4. In a similar way occasional isolations of types 3, 6 and 1 are possible in epidemics dominated by types 2 and 4. One reason for this might be the import of new types from other places. But in the absence of import from outside the appearance of these strains is difficult to explain. It is perhaps possible that these new types appear due to recombinations in nature. This possibiliy is being explored in our laboratory. In view of the importance of the so-called non-agglutinable vibrios (NAG), a successful effort was recently made in our laboratory to develop a phage-typing scheme for these vibrios. With the help of 4 bacteriophages of which one was obtained as a lytic mutant of a temperate bacteriophage and the remaining three were host range modifications of sewage water phages, 200 strains of NAG vibrios could be classified into 12 phage-types depending on their sensitivity patterns. Further studies are nesessary for evaluation of the scheme.

FLAGELLAR ANTIGENS OF CHOLERA VIBRIOS

Flagellar antigenic specificity provides a rapid and highly specific diagnostic tool for the identification of several bacterial species, a good example being the scheme in use for *Salmonella* species. Such schemes have been used to advantage in epidemiology, taxonomy and genetics. The flagellar antigens of *V. cholerae* have been investigated in recent years, in our laboratory[8].

It was found that all *V. cholerae* and NAG vibrios with a bacteriologically typical *V. cholerae* (Sakazaki[9]) were agglutinable with pure 'H' sera to all *V. cholerae* suspensions and with the 'H' serum of one NAG strain tested. Vibrio-like organisms which did not conform to Sakazaki's description did not agglutinate. Similar observations have recently been reported by Sakazaki[7] in 1970.

Reciprocal absorption analysis revealed the complete identity of flagellar antigens of all the *V. cholerae* and the NAG strain tested. These findings were confirmed with both hyperimmune and low titre antisera. These observations are at variance with the results of most earlier studies and it is suggested that the many subtypes of flagellar antigens described by earlier workers were a result of antigen variability, and flagellar artifacts resulting from prolonged storage on solid media, and are not related to the normal, motile organism.

Thus a typing scheme cannot be formulated for *V. cholerae* flagellar antigens but the uniformity of these antigens in all cholera vibrios is of potential importance as a rapid serodiagnostic and taxonomic tool.

EPIDEMIOLOGY

(*i*) The *V. cholerae* biotypes ElTor entered India in 1964 and by 1966 it completely replaced the pre-existing classical cholera (Mukerjee and Basu[10]). In 1967 a few *V. cholerae* of classical biotype could be isolated from carriers, in 1968 and 1969 from carriers and cases. It appears therefore, that classical cholera is still being mintained in a small fraction of the population in carriers and is capable of giving rise to occasional sporadic cases. Outbreaks caused by classical cholera, therefore, remain a probability. Another possibility is that classical cholera may be imported from East Pakistan where the infection is mainly due to classical cholera vibrios. In 1970 in the month of April an outbreak occurred in Calcutta caused by classical cholera Inaba phage-type 1. An interesting point about the causal strains of this outbreak was that they were all lactose fermenters. Though cholera is known to ferment lactose very slowly, these vibrios did so after overnight incubation. Taking this character and phage-typing as markers, the origin of the strains could be traced to the West Bengal-Pakistan border area where an outbreak started in the months of February–March when refugees were coming from Pakistan. The same type strains were also isolated from Madhya Pradesh in July where these refugees were sent for rehabilitation. From the chronological sequence it appears that the infection came from East Pakistan and spread in this country.

(*ii*) In 1965 we predicted that ElTor pandemic which started from Celebes in 1961 might spread westwards and may threaten the European countries. By 1965 it affected all the

West Pacific Island, the countries in East, South and Central Asia in its way and reached Asian part of USSR. This year it has spread further westwards and has reached Syria and the European countries including USSR and Sicily. Thus cholera has again gained further epidemiological importance. There are reports of heavy epidemics in Central Asia and North Africa also.

(*iii*) It has already been mentioned that in several cholera-like outbreak in recent years, the causative agents were the non-agglutinable vibrios. These vibrios are now frequently isolated from cases and carriers in Calcutta. Their pathogenicity for experimental animals has also been established[11]. Such strains referred to the WHO International Reference Centre for Vibrios in 1969 were studied by the phage-typing scheme developed for the NAG vibrios. It was interesting to observe that the strain from Eastern India belonged to type 1, those of South and West India belonged to type 3 and a few cities which are known to be endemic for *V. cholerae* biotype ElTor were also found to harbour multiple phage-types of these vibrios.

BACTERIOCINOGENY

Chakrabarty *et al.*[12] developed a bacteriocine typing scheme for the 0-1 *V. cholerae* strains based on eight indicator strains. They demonstrated eleven types amongst 425 strains that have been tested. 215 strains of NAG vibrios have been divided into ten major bacteriocine types with the help of 8 indicator strains comprising of different enterobacterial and vibrio strains[13]. The three major bacteriocine types could again be subdivided into two each on the basis of production of paradoxical reaction. Thus the total number of recognised bacteriocine types presently stands to 13 amongst NAG vibrios and some are common with those of 0-1 *V. cholerae*. The epidemiological significance of these schemes is yet to be evaluated. The studies on bacteriocine produced by vibrios are expected to reveal many interesting phenomena, advantage of one such being already utilized for subtyping the major bacteriocine types.

IMMUNITY AND IMMUNOPROPHYLAXIS

Cholera has been eliminated from the western countries by improvement in the hygienic standard of living. But it is now a disease of the developing countries. Prophylactic immunization of the susceptible population is one of the most important measures employed in the control of epidemic of cholera for nearly three quarters of the century. In developing countries with limited funds and equipment for improving the standard of sanitation and safe drinking water supply cholera control programme continues to be based largely on vaccination. None-the-less, the efficacy of cholera vaccine had not been properly evaluated until 1964 when a number of field trials were carried out in Calcutta, the Philippines and Dacca. The results of these trials have not borne out the dependability of inoculation programme which are being employed extensively in cholera control all over the world. The trials have clearly brought out the importance of further research for improving the immunizing potency of cholera vaccine.

One section of the scientists in the United States and in India are working on the possibility of cholera toxin or toxoid being used as an effective prophylactic agent against cholera. It is now generally accepted that the diarrhoea of cholera is caused by the action of enterotoxin elaborated by cholera vibrios in the small intestine. This group of workers, therefore, justified their effort to use cholera toxin or toxoid for prophylactic immunization. We are trying to follow a different line of approach. Cholera is an infection in the intestinal tract. The causative vibrios remain limited to the gut of the patient and have no tendency to enter the tissue or blood circulation. The vast majority of patients are cured by simply replacement of fluid and electrolyte loss. A cholera case begins to recover within 24 to 48 hours of the onset of symptoms before there has been sufficient time of humoral antibodies to develop. For prophylaxis against cholera, therefore, there seems to be required production of effective immunity in the mucous membrane of the intestinal tract. It has not been possible to achieve this satisfactorily by injection of killed culture of cholera vibrios. We therefore carried out laboratory studies with a view to develop an improved method of cholera prophylaxis based on the use of living culture of a naturally occurring avirulent ElTor strain for administration by the oral route[14].

Earlier laboratory studies on the possibility of basing a live oral cholera vaccine on a naturally avirulent strain of ElTor vibrio showed that the strain is capable of multiplication in the gastrointestinal tract of rabbits resulting in the production of antibacterial and antitoxic immunity[15]. In order to examine the safety and immunogenic value for human use of this proposed vaccine, a systematic trial was carried out on 25 human volunteers. Following oral administration of the vaccine after neutralization of gastric acidity, the volunteers developed statistically significant increases in their vibriocidal antibody level. Copro-antibodies could also be demonstrated in stool samples within a week of vaccination[16]. Serum and copro-antibodies persisted unchanged during the period of observation of 6 weeks and 3 months respectively. None of the volunteers suffered any ill-effect during the course of the trial. It has been concluded that the proposed vaccine is safe for human use and is likely to protect against cholera, although its protective value has still to be confirmed in a field trial.

---

1. Dey, S. N. and Chatterjee, D. N., *J. Pathol. Bacteriol.*, **1953**, **66**, 559.
2. Lindenbaum, J., Greenough. W. B. III, Benenson, A. S., Oseasohn, R. O., Rizvi, S. and Saad, A., *Proceedings of the Cholera Research Symposium*, Honolulu, Hawaii, PHS, USDHEW, Washington DC, 1965, p. 200.
3. Aldova, E., Laznickova, K., Stepankova, E. and Lietava, J., *J. Infect. Dis.*, **1968**, **118**, 25.
4. *WHO Manual on Cholera Control*, WHO, SEA/Cholera/II Rev, 1970, **1**, **3**.
5. Burrows, W. and Kaur, J., *Ann. New York Academy of Sciences*, **1971**, **176**, 323.
6. Minutes of the IAMS. Sub-Committee on Taxonomy of Vibrios, *Internat. J. Syst. Bact.*, **1966**, **10**, **135**.
7. Sakazaki, R., Tamura, K., Gomez, C. Z. and Sen, R., *Japan J. Med. Sci. Biol.*, 1970, **23**, **13**.
8. Bhattacharya, P. K., Narayanaswami, A. N. and Mukerjee, S., *National Seminar on Immunity and Immunoprophyloxis in Cholera*, Calcutta, March, 1970.
9. Sakazaki. R., Gomez, C. Z. and Sebald, M., *Japan J. Med. Sci. Biol.*, **1967**, **20**, **265**.
10. Mukerjee, S. and Basu, S., *Trop. Geogr. Med.*, 1957, **19**, 138.
11. Sil, J., Sanyal, S. C., Dutta, N. K. and Mukerjee, S., *National Seminar on Immunity and Immunoprophylaxis in Cholera*, Calcutta, March, 1970.
12. Chakrabarty, A. N., Adhya, S., Basu, J. and Dastidar, S. G., *Infec. Immun.*, **1**, **293**.
13. —, Sil, J. and Mukerjee, S., *National Seminar on Immunity and Immunoprophylaxis in Cholera*, Calcutta, March, **1970**.
14. Mukerjee, S., *Bull. Wld. Hlth. Org.*, 1963, **29**, 753.
15. Bhattacharya, P. K., Narayanaswami, A. N. and Mukerjee, S., *J. Infect. Dis.*, 1968, **95**, 255.
16. Sanyal, S. C. and Mukerjee, S., *Bull. Wld. Hlth. Org.*, 1969, **40**, 503.

MAGNETIZATION OF A DOLERITE DYKE IN JHARIA COALFIELD

JAGDEO SINGH AND M. KRISHNA RAO

Department of Applied Geophysics, Indian School of Mines, Dhanbad

POST-lower Gondwana (Jurasso-Cretaceous dolerite dykes are found intruding the Gondwana sediments in the Jharia Coalfield. C. S. Fox[1] suggested the possibility of these dykes belonging to the Deccan trap period of igneous activity. Based on petrological study, Sadashivaiah[2] corroborated Fox's view. Sadashivaiah further states in his paper that the mineral composition of these dykes resembles very closely some of the middle and upper flows (especially flows 10 and 25) of the basaltic Deccan trap lavas of Bhusaval (Fermor[3]).

Out of the three dykes which tend to merge in the northern part of the Jharia Coalfield, the easternmost one passing through Tundu (23° 47′ N : 86° 16′ E), has been chosen for the present study. Tundu is 12 miles west of Dhanbad. The dyke is about 2 miles long and 10 to 30 feet thick and crosses the lowest Barakars and Talchirs and continues into the Archean metamorphics north of the sedimentary basin.

Four magnetic traverses were taken across the dyke near Tundu using Schmidt vertical force variometer of scale constant 25 γ/sc. div. Profiles are drawn and the position of the dyke on the traverse line, when exposed, is shown (Fig. 1).

The intensity and direction of NRM has been studied with an astatic magnetometer on oriented samples cut in the form of cylinders 1″ long and 1″ dia. (discs). Volume susceptibility (k) has been determined with an A.C. bridge. The ratio J_n/J_i (Koenigsberger ratio, Q_n) is calculated. The results are shown in Table I. J_n and J_i stand for intensity of NRM and induced magnetization and D and I for declination (east of north) and inclination (positive downwards) of NRM respectively J_n^z, J_i^z and Q_n^z are the vertical components. For Dhanbad the values of magnetic elements are :

Total intensity, $F = 0{\cdot}45$ Oest.

Vert. Comp., $Z = 0{\cdot}25$ Oest.

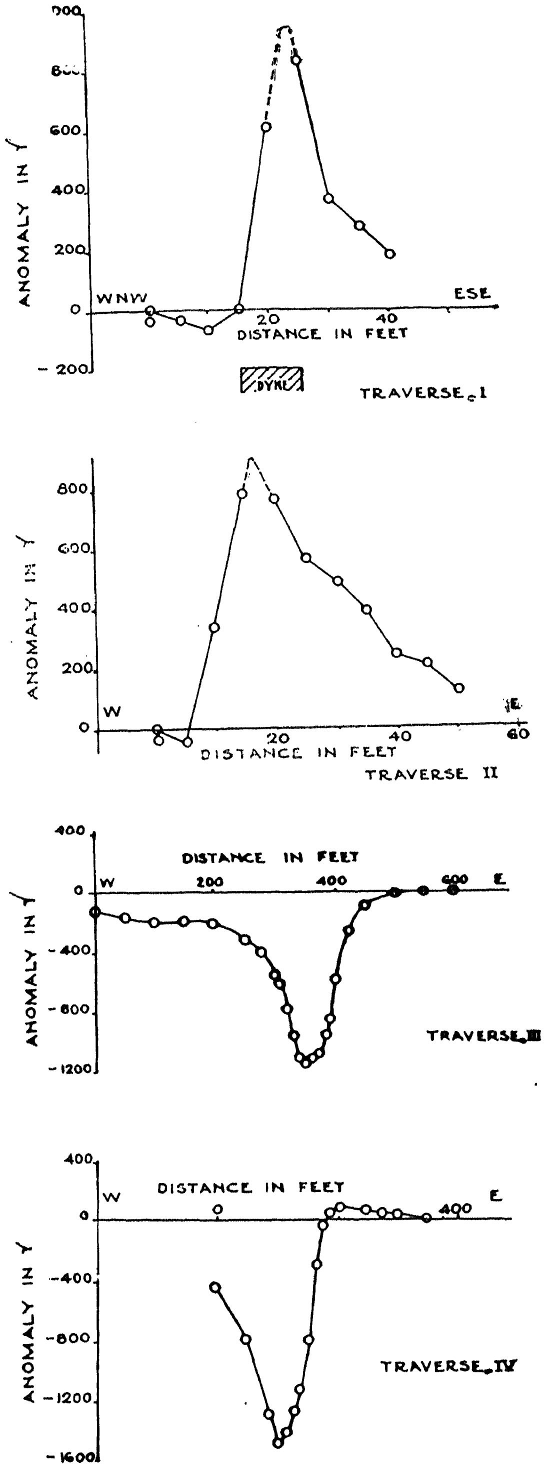


FIG. 1. Magnetic profiles of vertical intensity across the dyke.

Declination, $D = 0°$.

Inclination, $I = +34°$.

The volume susceptibility (k) of 5 samples have a range of 1787×10^{-6} to 2625×10^{-6} c.g.s. units and the average of these is 2203×10^{-6} c.g.s. units. This has been determined with an A.C. bridge in a field of the order of the earth's field.

INTERPRETATION OF MAGNETIC PROFILES

The basis for interpretation has been discussed by the authors[4] in an earlier paper.

It is seen from Table I that Q_n^{z} is more than 5. This shows that more than 80% of the anomaly is caused by remanence. Hence only remanence is considered in interpreting these profiles.

Traverses I and II were 150 feet apart and samples T 1 and T 1 A have been collected in between them. These samples have strong remanence of 22×10^{-3} and 36×10^{-3} c.g.s. units and have westerly magnetization for the horizontal component and have shallow inclination. The traverse direction is also E-W. This transverse magnetization, along with an upward vertical component, should give rise to a great low on the western side of the dyke and a small high on the eastern side. But the actual result is just the reverse of this. It shows that probably the magnetization below is different, and the surface samples collected here are probably magnetized by lightning.

Traverses III and IV taken 5 furlongs apart have similarity in their magnetic profiles and show distinct negative anomalies of about 1200 γ and 1500 γ. The thickness of overburden is not known but it may be about 10 feet. The samples T 2, T 3 and T 3 A which are similar in direction and intensity of NRM have been collected from the part of the dyke about 100 feet away and they explain the nature of the anomaly over the two traverses. The horizontal component of NRM is nearly northwards and the traverses are E-W; the magnetization has moderate inclination. Thus the direction of NRM of these samples explains the negative anomalies.

Applying the depth rule, the depth to the magnetic line as obtained from the magnetic profiles is 45 ft and 60 ft from the ground surface for traverses III and IV respectively. Assuming the overburden to be 5 ft (from cuttings nearby) the magnetic line is taken to be situated at depths of 40 ft. and 50 ft from the top surface of the dyke (the height of magnetometer, 3 ft from ground surface, has been neglected), These figures are comparable with those obtained for the Amarpur dyke[4].

Assuming that the intensity of NRM is uniform in the vertical direction and taking the thickness of the dyke (b) to be 30 ft., for the magnetic anomalies of 1200 γ and 1500 γ and depths (d) of 45 and 60 ft., the intensity of NRM as calculated from the formula

$$\Delta Z_{\max} = 2 J_n \cdot b/d$$

comes to be 9×10^{-3} to 15×10^{-3} c.g.s. units respectively. The surface samples, although unweathered, have values ranging from $3 \cdot 5 \times 10^{-3}$ to $5 \cdot 7 \times 10^{-3}$ c.g.s. units. This shows that the intensity of NRM is greater at depth. This disparity can be due to any one of the three reasons: (*i*) the intensity of NRM is greater at depth; (*ii*) the dyke is broader at depth, (*iii*) the depth rule is not applicable in this case. (*iv*) is improbable, as the usual value of samples from such dykes in this coalfield is not more than 6×10^{-3} c.g.s. units. Such a disparity is not found in the case of Amarpur dyke[4].

DISCUSSION

Taking the 3 samples T 2, T 3 and T 3 A, the declination and the moderate inclination of NRM is similar to the magnetic direction of upper Deccan traps. This corroborates the views of Sadashivaiah[2] and Fox[1], stated earlier in this paper. The magnetization of the Tundu dyke corresponds to normal magnetization in southern hemisphere.

Amarpur dolerite dyke[4], which is 15 miles east of Tundu dyke, has a similar magnetization but the latter has a much steeper inclination of 68° similar to Rajmahal traps[5]. The magnetic profiles in general for both the dykes are similar. There is similarity in other respects also, such as, J_n, k, Q_n and the order of anomaly. The results of 2 samples (J_3 and J_4) from Jamuniatand dyke (4 miles south-west of Tundu) are given in Tables I and II.

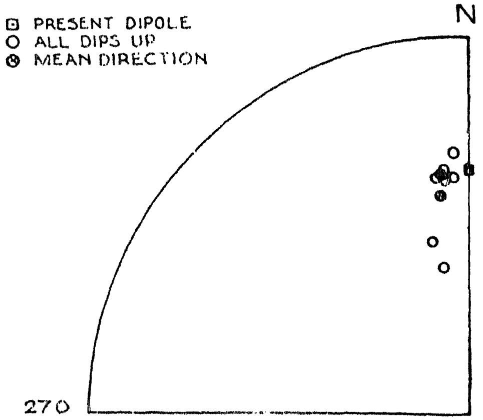


FIG. 2. Tundu dyke: Polar Equal Area Projection.

TABLE I

Magnetization of Tundu and Jamuniatand dykes

Sl. No.	Sample No.	No. of discs	D	I	$J_n \times 10^3$	$k \times 10^6$ c.g.s. units	$J_i \times 10^3$	Q_n	$J_n^s \times 10^3$ c.g.s. units	$J_i^s \times 10^3$	Q_n^s
1	T1	1	286	−28	22·420	2624	1·181	19·0	14·220	0·656	21·7
2	T1A	5	276	−12	36·166	2625	1·037	34·9	8·125	0·576	14·1
3	T2	2	351	−51	3·506	1787	0·804	4·4	2·820	0·447	6·3
4	T3	5	352	−34	5·661	2171	0·977	5·8	3·220	0·543	5·9
5	T3A	2	355	−34	4·410	1809	0·854	5·2	2·538	0·474	5·4
6	J3	3	327	−58	3·787	2064	0·921	4·1	3·220	0·516	6·2
7	J4	3	350	−38	3·703	2357	0·819	4·5	2·302	0·455	5·1

TABLE II

Magnetic direction and palaeolatitude of dykes in Jharia Coalfield and Amarpur

Sl. No.	Locality	Lat. N.	Long. E.	Mean direction D	I	α_{95}	k	N	λ	Reference
1	Tundu ..	23° 47′	86° 16′	353	−40	15	67	3	23 S	..
2	Jamuniatand ..	23° 45′	86° 12′	341	−49	..	..	2	..	..
3	Kharkari ..	23° 46′	86° 11′	350	−28	12·7	40	3	15 S	Athavale[7]
4	Jamuniatand ..	23° 36′	86° 14′	338	−40	8	41	8	23 S	,,
5	Amarpur ..	24°	86° 30′	323	−68	10·5	29·4	8	51 S	Singh and Rao[9]

k = Precision parameter; N = Number of samples; λ = Palaeolatitude.

The fact that the NRM directions of the samples are far away (in inclination) from the present geomagnetic direction of the place shows that the rocks are magnetically stable. Besides this, the stability has been tested by remeasurement of NRM after one month with the specimens stored in the reversed direction[6]. It has been found in the present investigation that there is practically no difference in the two sets of readings (one set taken after storing for a month in normal position and the other set in reversed position).

The results of this investigation are compared with those of Athavale[7] in Table II. Tundu dyke is two miles east of Athavale's dyke of site 9 and this dyke of site 9 is 2 miles east of his dyke of site 10. In fact all these 3 dykes belong to the same system, as is seen from the map of Jharia Coalfield.

It is interesting to note that the Amarpur dyke has a magnetization similar to that of Rajmahal traps while the Tundu dyke (15 miles west of Amarpur) is similar to that of upper Deccan traps.

1. Fox, C. S., "The Jharia Coalfield," *Mem. Geol. Surv. Ind.*, **1930, 56, 114.**
2. Sadashivaiah, M. S., *J. Geol. Min. Met, Soc. Ind.*, **1952, 24,** 105 (Silver Jubilee Volume).
3. Fermor, L. L., *Rec. Geol. Surv. Ind.*, **1925, 58,** Pt. II.
4. Singh, Jagdeo and Krishna Rao, M., *Pure & Applied Geophysics* (*Pageoph*), 1970/V, **82,** 133.
5. Clegg, J. A., Radakrishnamurty, C. and Sahasrabudhe, P. W., *Nature*, 1958, **181,** 830.
6. Blundell, D. J., *Scientific Reports No. 39.* British Antarctic Survey, 1962.
7. Athavale, R. N. and Verma, R. K., *Geophy. J.R. Astr. Soc.*, Aug. 1970, **20** (3), 303.

MOLECULAR ORBITAL STUDIES OF ELECTRON DONOR-ACCEPTOR SYSTEMS

A. S. N. MURTHY* AND S. N. BHAT
Department of Chemistry, Birla Institute of Technology and Science,
Pilani (Rajasthan)

THERE have been exhaustive studies of electron donor-acceptor interactions in the light of Mulliken's theory[1,2]. A few workers[3-5] have carried out some quantum mechanical calculations on donor-acceptor complexes. We have been interested for some time in molecular orbital calculations of the hydrogen bond[6-8] and we considered it interesting to extend our studies to another aspect to electron donor-acceptor systems, namely, charge-transfer complexes. In this communication, we report the results obtained from extended Huckel (EHT)[9] and CNDO/2[10] calculations on some donor-acceptor complexes. The systems presently examined include $\pi - \pi$, $\pi - \sigma$ and $n - \sigma$ types of interactions[1,2]. We have reported elsewhere the results of M.O. studies of the $n - v$ systems[11] as well as the $NH_3 + HF \rightarrow NH_4F$ system[12].

The interaction between a methyl cation (σ acceptor) and ethylene (π donor) was investigated by Paldus and Polak[13] who found an energy minimum at a donor-acceptor distance of 2·65 Å. The carbon atom of the planar methyl cation has an empty p orbital and this will be utilized in the formation of a bond with an approaching nucleophile, the product formed having a tetrahedral geometry. In view of this, the effect of changing the geometry of CH_3^+ on the stability of the donor-acceptor complex has now been examined. For this purpose, we have calculated the potential energy curves (Fig. 1) by the EHT method as a

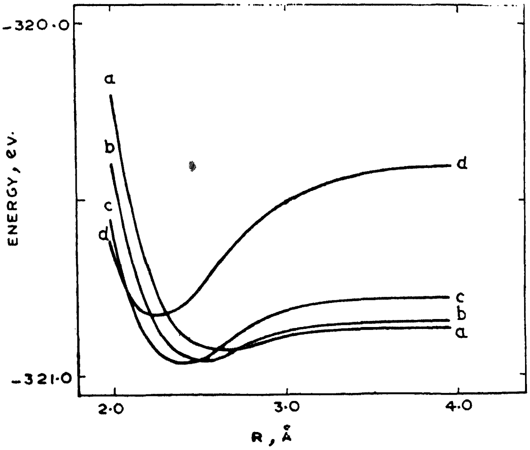


FIG. 1. Total energy (by the EHT method) of the methyl cationethylene complex as a function of intermolecular separation (R) for different distortions of the methyl-cation : (*a*) planar methyl cation, (*b*) two C–H bonds bent out-of-plane by 10°, (*c*) all the C–H bonds bent out-of plane by 10° and (*d*) all the C–H bonds bent out-of-plane by 20°.

---

* To whom all the correspondence may be addressed.

function of the out-of-plane bending angle of the methyl cation. We find that the complex is more stable when the C–H bonds are bent out-of-plane by 10°, larger distortions destabilizing the complex. The charges at the donor and acceptor sites clearly show evidence for σ charge transfer (Table I). The Mulliken overlap population of the C–C bond of ethylene decreases from 1·28 to 1·17 in the complex. We also calculated the potential energy curves employing the CNDO/2 method but the dissociation energy by this method was unreasonably large while the equilibrium distance was very small (1·45 A). The CNDO charges, however, show donor–acceptor charge transfer and provide an estimate of the dipole moment as 4·0 D.

We could not find any minimum in the potential energy curve in the interaction of methyl cation with benzene, but the dissociation energy estimated as the difference between the total energy of the complex and the sum of the energies of the donor and the acceptor is around 1·0 kcal/mole. Here again we see the evidence for σ type charge transfer.

Literature abounds in the study of complexes of π and n donors with halogen acceptors, particularly iodine[1,2,14]. Several suggestions have been made regarding the structure of benzene-halogen complexes[1,2,13,15]. We considered it interesting to test the various types of models by calculating the energies of benzene–fluorine complexes by the EHT method. Of all the models, we find the axial model[1,14] to possess the lowest energy (Table I) and the oblique model to have the highest energy. None of these models, however, gave an energy minimum with respect to the donor–acceptor distance. The dissociation energy computed as the difference between the energy of the complex and the sum of the energies of components was much too large (40 kcal). The EHT charges indicated σ donor–acceptor charge transfer. We have also examined the benzene–tetracyano-

TABLE I

Charge densities in a few donor–acceptor systems by the EHT and CNDO/2 methods

System	Total energy, E_T, ev		Charges[a]			
	EHT	CNDO/2	EHT method		CNDO/2 method	
			Donor site	Acceptor site	Donor site	Acceptor site
$CH_3^+ + C_2H_4$ ..	− 320·9592	− 716·1073	σ 2·8318 (3·0257) π 1·1990 (1·1992)	σ 2·5948 (2·1834) π 1·2342 (1·2342)	σ 2·8527 (3·0241) π 1·0183 (1·0000)	σ 3·0344 (3·5220) π 0·9697 (0·0349)
CH_3^+ Benzene ..	− 638·0500	..	σ 2·9180 (2·9218) π 1·1836 (1·1832)	σ 2·1769 (2·0787) π 1·2340 (1·2340)	.. ..	.. ..
F_2+ Benzene[b] ..	− 878·5554	..	σ 2·9181 (2·9218) π 1·1836 (1·1836)	σ 5·9980 (5·0000) π 2·0000 (2·0000)	.. ..	.. ..
Tetracyanoethylene + C_2H_4	−1020·7843	..	σ 2·8854 (3·0257) π 1·0589 (1·1992)	σ 2·8281 (2·7969) π 0·8493 (0·8672)	.. ..	.. ..
Tropylium ion + C_2H_4 ..	− 813·9530	..	σ 2·2340 (3·0257) π 1·1999 (1·1992)	σ 2·7817 (2·7817) π 1·1819 (1·1819)	.. ..	.. ..
F_2+ Pyridine ..	− 888·3119	−2891·8325	σ 3·6219 (4·4827) π 1·4264 (1·4264)	σ 5·998 [illegible] (5·0001) π 2·0000 (2·0000)	σ 3·8836 (4·0822) π 1·1949 (1·1725)	σ 5·3187 (5·0000) π 1·9998 (2·0000)
F_2+ Dimethyl ether ..	− 740·6955	−2521·2813	σ 5·1533 (5·1537) π 1·980 [illegible] (1·9808)	σ 5·0000 (5·0000) π 2·0000 (2·0000)	σ 4·1626 (4·2602) π 1·9562 (1·9491)	σ 5·2337 (5·0000) π 2·0000 (2·0000)

[a] The values in parentheses represent the charge densities of the free donor and acceptor sites.

[b] For the lowest energy structure (axial model).

ethylene complex by the EHT method and found no energy minimum in the potential energy curve, in agreement with the observation of Wold[16]. The EHT charges clearly show σ donor-acceptor charge transfer (Table I) and a decrease in the Mulliken overlap population of the C=C bond of ethylene. We noticed similar changes in the case of tropylium ion-ethylene complex (Table I); this system also failed to show any energy minimum.

We investigated the pyridine-fluorine and dimethyl ether-fluorine systems as typical cases of $n-\sigma$ interaction. While in the former system the F—F bond was kept collinear with nitrogen (sp^2 lone pair direction), it was along the sp^3 lone pair direction in the latter system. No minimum could be found in the potential energy curves by the EHT method for both these complexes However, the charge densities showed the expected charges (Table I). The Mulliken overlap population of the F...N bond in the pyridine-fluorine system was 0·001; the overlap population of the F...O bond was negligible (0·0003). The overlap population and the F—F bond decreases on complexation and the charge densities vary as shown in Table I. Attempts to change the method of calculation of the off-diagonal elements did not affect the results significantly. CNDO/2 calculations on these two complexes indicated extraordinarily high stabilities with large dissociation energies; the equilibrium donor...F distances were $\sim 1{\cdot}8$ Å. The calculated dipole moment of the ether and pyridine complexes with F$_2$ were 4·9 and 7·6 D respectively, in agreement with the experimental values[17,18] of the corresponding iodine complexes. The dipole moment values are of importance in providing the percentage dative structure in the ground state of the complex.

The authors are thankful to Professor C. N. R. Rao, Indian Institute of Technology, Kanpur, for valuable discussions. Thanks are also due to the staff of the computer center IITK for facilities on the IBM 7044/1401 computers.

---

1. Mulliken, R. S. and Person, W. B., *Molecular Complexes, A Lecture and Reprint Volume*. John Wiley and Sons, Inc., New York, N.Y., 1970.
2. (*a*) Rao, C. N. R. and Murthy, A. S. N., In *Spectroscopy in Inorganic Chemistry*, Ed. by C. N. R. Rao and J. R. Ferraro, Academic Press, Inc., New York, 1970, **1**, 107.
   (*b*) —, Bhat, S. N. and Dwivedi. P. C., *Appl. Spec. Revs.*, 1971, **5**, 1.
3. Dewar, M. J. S. and Thompson, C. C., *Tetrahedron Suppl.*, 1966, **7**, 97.
4. (*a*) Hanna, M. W., *J. Amer. Chem. Soc.*, 1968, **90**, 285.
   (*b*) — and Williams, D. E., *Ibid.*, 1968, **90**, 5358.
   (*c*) Lippert, J. L., Hanna, M. W. and Trotter, P. J., *Ibid.*, 1969, **91**, 4035.
5. (*a*) Flurry, R. L., *J. Phys. Chem.*, 1965, **69**, 1927.
   (*b*) —, *Ibid.*, 1969, **73**, 2111.
   (*c*) — and Politzer, P., *Ibid.*, 1969, **73**, 2787.
6. (*a*) Murthy, A. S. N. and Rao, C. N. R., *Chem. Phys. Letts.*, 1968, **2**, 123.
   (*b*) —, Davis, R. E. and Rao, C. N. R., *Theoret. Chim. Acta.* (*Berl.*), 1969, **13**, 81.
7. (*a*) —, Bhat, S. N. and Rao, C. N. R., *J. Chem. Soc.* (*London*), Sect. A., 1970, p. 1251.
   (*b*) —, Rao, K. G. and Rao, C. N. R., *J. Amer. Chem. Soc.*, June Issue, 1970, **92**, 3544.
8. — and Rao, C. N. R., *J. Mol. Structure*, 1970, **6**, 263.
9. Hoffmann, R., *J. Chem. Phys.*, 1963, **39**, 1397.
10. Pople, J. A. and Coworkers, *Ibid.*, 1965, **435**, 129, 136; *Ibid.*, 1966, **44**, 3289.
11. Kudchadker, S. A. and Rao, C. N. R., *Theoret. Chim. Acta*, 1970, **18**, 258.
12. Rao, C. N. R. and Murthy, A. S. N., *J. Mol. Structure*, 1971 (In press).
13. Paldus, J. and Polak, R., *Theoret. Chim. Acta*, 1966, **5**, 369.
14. Briegleb, G., *Elektronen–Donator–Acceptor–Komplexe*, Springer–Verlag, Berlin, 1961.
15. Person, W. B., Cook, C. F. and Friedrich, H. B., *J. Chem. Phys*, 1967, **46**, 2521.
16. Wold, S., *Acta. Chem. Scand.*, 1966, **20**, 2377.
17. Bhat, S. N. and Rao, C. N. R., *J. Amer. Chem. Soc.*, 1968, **90**, 6008.
18. Kobinata, S. and Nagakwa, S., *Ibid.*, 1966, **88**, 3905·

LETTERS TO THE EDITOR

A NOTE ON HYDROMAGNETIC FLOW NEAR AN OSCILLATING WALL

RECENTLY, we[1] have examined the Rayleigh's problem in hydromagnetics, *i.e.*, the flow of a viscous incompressible fluid past an infinite flat wall in the presence of a transverse magnetic field. In this paper we consider the flow about an infinite flat wall which executes linear harmonic oscillations parallel to itself.

For the purpose of simplifying the mathematical analysis, we restrict ourselves to the limiting case obtained by assuming the magnetic Prandtl number ($P_m = \mu \sigma \nu$) to be small (a plausible assumption for most electrically conducting fluids), so that the applied magnetic field is virtually undistorted by the electric currents flowing in the fluid.

The basic equations governing the unsteady motion of incompressible, viscous and electrically conducting fluids in the presence of magnetic field as in reference[1] are:

$$\frac{\partial u}{\partial t} = \nu \frac{\partial^2 u}{\partial y^2} - mu, \tag{1}$$

where

$$m = \frac{\sigma \mu^2 H_0^2}{\rho}$$

Owing to the condition of no slip at the wall, the fluid velocity at it must be equal to that of the wall. We suppose that this motion is given by

$$\begin{aligned} & u = 0 \quad \text{for} \quad t \leq 0, \\ & \left.\begin{aligned} u &= U_0 \cos nt \quad \text{for} \quad y = 0, \\ &= 0 \quad \text{for} \quad y \to \infty \end{aligned}\right\} \text{ and for } t > 0. \end{aligned} \tag{2}$$

We introduce the non-dimensional variables

$$\phi = u/U_0, \ \eta = y\,(n/2\nu)^{1/2}. \tag{3}$$

It is easily verified that the solution of (1) subject to (2) in terms of the variables of (3) is

$$\phi = e^{-\eta (2r)^{1/2} \cos (\theta/2)} \cos \{nt - \eta\,(2r)^{1/2} \sin (\theta/2)\} \tag{4}$$

where

$$r = \left(\frac{\alpha^2}{\beta^2} + 1\right)^{1/2}, \quad \theta = \tan^{-1}(\beta/\alpha), \quad \alpha = mt, \quad \beta = nt. \tag{5}$$

Now we can look upon α and β as hydromagnetic and frequency parameters in the unsteady motion. When we substitute $\alpha = 0$ (hydrodynamic case) in eq. (4) we recover the solution as in reference[2], *i.e.*,

$$\phi = e^{-\eta} \cos (\beta - \eta). \tag{6}$$

The non-dimensional velocity profile ϕ thus has the form of a damped harmonic oscillation, the amplitude of which is $e^{-\eta (2r)^{1/2} \cos (\theta/2)}$ in which a fluid layer at a distance y has a phase lag $y\,(nr/\nu)^{\frac{1}{2}} \sin (\theta/2)$ with respect to the motion of the wall. For fixed values of the frequency parameter β, the effect of increasing the hydromagnetic parameter α is always to decrease the amplitude and the phase lag of the velocity profile at any point of the fluid.

Dept. of Engineering Mathematics,
Andhra University, Waltair,
June 11, 1971.

V. V. RAMANA RAO.

---

1. Vidyanidhi, V. and Ramana Rao, V. V., *Curr. Sci.*, 1968, **37**, 427.
2. Schlichting, H., *Boundary Layer Theory*, Pergamon Press, 1955, p 85.

PROTON MAGNETIC RESONANCE STUDY OF LITHIUM FORMATE MONOHYDRATE

PROTON pairs in water molecules of hydrated crystals form typical two spin systems and the intramolecular dipole-dipole interaction results in a splitting of the PMR spectrum. Following Pake,[1] the splitting of the resonance lines, $\triangle H$, is given by:

$$\triangle H = 2\alpha\,[3 \cos^2 \delta \cos^2 (\phi - \phi_0) - 1].$$

The X-ray crystal structure analysis of lithium formate monohydrate (LFMH) was carried out recently.[2] LFMH crystallises in the orthorhombic system with a tetramolecular unit cell of dimensions $a = 6{\cdot}504$ Å, $b = 9{\cdot}989$ Å, $c = 4{\cdot}856$ Å in the space group $Pbn2_1$. The crystallographically equivalent positions are given by (x, y, z); $(\frac{1}{2} - x, \frac{1}{2} + y, z)$; $(\frac{1}{2} + x, \frac{1}{2} - y, \frac{1}{2} + z)$; $(-x, -y, \frac{1}{2} + z)$. X-ray workers were able to locate the formate hydrogen and one of the water hydrogens at about 1 Å from the parent atoms. These studies as well as the infrared and Raman effect studies[3-6] support the existence of hydrogen bonding in this crystal.

A large single crystal of LFMH was grown by slow evaporation of the aqueous solution, The crystal was rotated about the a-axis and spectra were recorded for 18 orientations at 10° intervals, using a modified PKW spectrometer. A standard water proton derivative curve was prepared from the best resolved spectrum. Two such pairs of derivative curves in conjunction with the central signal were used to resolve the experimental curves. ΔH value was measured for each pair and they were assigned to the two vectors making use of the criteria that

$$H_{\min.} = 2\alpha$$

and

$$H_{\max.} = 2\alpha(3\cos^2\delta - 1) \text{ at } \phi = \phi_0$$

The theoretical Pake curves were plotted and the values of α, ϕ_0 and δ were determined using the method of least squares. A value of 9·69 gauss for 2α was obtained for both the p-p vectors, thus giving a value of 1·63 ± 0·03 Å for the interproton distance.

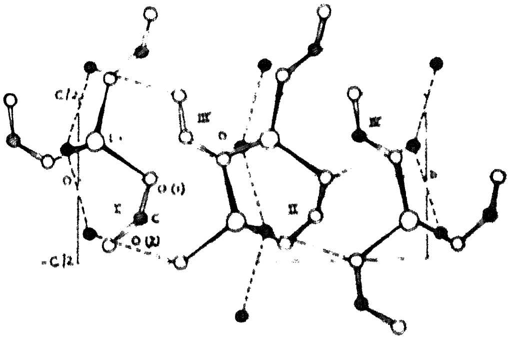


FIG. 1. Crystal structure of LFMH projected on the b–c plane.

The ϕ_0 and δ values obtained from the present experiment as well as the orientation of the line joining the acceptor oxygen atoms calculated from X-ray data are given in Table I.

TABLE I

	ϕ_0	δ
$(P-P)_1$	41° 39′	11° 15′
$(P-P)_2$	134° 6′	1[illegible]° 6′
$O(1)(x, y, z) - O_w$ $(-x, -y+1, \frac{1}{2}+z-1)$	44° 30′	16° 30′
$O_w(x, y, z) - O(1)$ $(-x, -y+1, -1+\frac{1}{2}+z)$	136° 30′	16° 30′

The possible H bonding schemes in LFMH were pointed out by X-ray workers and the bond lengths and angles were found to be

$O_w - O(1)$ 2.732 Å

$O_w - O(-x, -y+1, \frac{1}{2}+z)$ 2·930 Å

$O(1) - O_w - O_w(-x, -y+1, \frac{1}{2}+z)$ 118·8°

$O(1) - O_w - O_w(-x, -y+1, \frac{1}{2}+z-1)$ 86·4°

The X-ray workers suggested that the second water hydrogen can either occupy a single potential minimum and be close to one of the two water oxygens or be disordered occupying two potential minima between these two water oxygens. Our results indicate that the p-p vector has two orientations one along $O(1)-O_w$ and the other along $O_w-O(1)$ as shown in Table I.

The authors wish to thank Prof. R. S. Krishnan and Prof. P. S. Narayanan for their kind interest in the work. One of the authors (K. M.) wishes to thank the CSIR for the award of a Junior Fellowship.

Dept. of Physics, K. MUTHUKRISHNAN.
Indian Institute of Sci., J. RAMAKRISHNA.
Bangalore-12, India,
July 22, 1971.

---

1. Pake, G. E., *J. Chem. Phys.*, 1948, **16**, 327.
2. Mohana Rao, J. K. and Viswamitra, M. A., *Ferroelectrics*, 1971, **2**, 209.
3. Harvey, K. B., Morrow, B. A. and Shurvell, H. F., *Canad. J. Chem*, 1963, **41**, 1181.
4. Donaldson, J. D., Knifton, J. F. and Ross, S. D., *Spectrochim. Acta*, 1961, **20**, 847.
5. Ramanujam, P. S., *Ind. J. Pure Appl. Phys.*, 1969, **7**, 420.
6. Cadene, M., *Compt. Rend. Acad. Sci. Paris*, 1970, **270 B**, 909.

LATTICE THERMAL EXPANSION OF LEAD TUNGSTATE

As a part of a general programme of 'X-ray studies on scheelite-type compounds', we have already published the results on the precision determination of the lattice parameters and thermal expansion of KIO_4[1], $NaIO_4$[2], $SrWO_4$[3], $BaWO_4$[4], $CaMoO_4$[5] and $CdMoO_4$[6]. The present note reports similar results obtained on lead tungstate, an isotype of scheelite.

A single crystal of $PbWO_4$ was crushed to fine powder form. The powder was heated at 650° C for 12 hours and cooled to room temperature in about 20 hours. The annealed powder was used to fill the specimen cup of the back reflection focusing camera.[7] The experimental technique employed and the procedures used in the evaluation of the accurate values of the lattice parameters along with their standard errors are essentially the same as described in earlier publications.[3-6] Eight powder photographs were taken at different temperatures between 28° and 355° C. The reflections measured and used in the evaluation of the lattice parameters were, $(1.1.14)_{\alpha_1\alpha_2}$, $(624)_{\alpha_1\alpha_2}$ $(448)_{\alpha_1\alpha_2}$, $(4.0.12)_{\alpha_1\alpha_2}$, $(5.1.10)_{\alpha_1\alpha_2}$, $(608)_{\alpha_1\alpha_2}$

and $(4.2.12)_{\alpha_1\alpha_2}$. These were recorded in the Bragg angle region between 66° and 85°.

In Table I, the lattice parameters of $PbWO_4$ obtained at room temperature are compared with a few others available in literature.

TABLE I

Comparison of the lattice parameters of $PbWO_4$ at room temperature

Source		a (Å)	c (Å)
Vegard and Refsum[8]	..	5·453	12·034
Aanerud[9]	..	5·464	12·055
Sillen and Nylander[10]	..	5·459	12·040
Swanson *et al.*[11]	..	5·4619	12·049
Present study	..	5·4628 ±0·0002*	12·0484 ±0·0005*

***** Standard errors as calculated by Jette and Foote's[12] method.

It can be seen that the parameters obtained in the present investigation agree with those reported by Swanson *et al.*[11]

The lattice parameters obtained at different temperatures are given in Table II.

TABLE II

Lattice parameters of $PbWO_4$ at different temperatures

Temp. °C.	a (Å)	c (Å)
28	5·4628	12·0484
70	5·4652	12·0595
105	5·4669	12·0688
165	5·4693	12·0824
210	5·4712	12·0945
265	5·4733	12·1087
310	5·4759	12·1207
355	5·4780	12·1338

The temperature variation of the parameters is shown in Fig. 1. It can be seen from these plots that while the *a*-parameter exhibits only a small non-linearity, the c-parameter shows a pronounced temperature dependence. The temperature variation of these parameters can be represented by the following expressions obtained by the usual statistical method:

$$a_t = 5{\cdot}46190 + 4{\cdot}436 \times 10^{-6}\ t + 1{\cdot}269 \times 10^{-9}\ t^2\ \text{Å}.$$

$$c = 12{\cdot}04237 + 23{\cdot}646 \times 10^{-5}\ t + 55{\cdot}760 \times 10^{-9}\ t^2\ \text{Å}.$$

Here t is the temperature in degrees Centigrade.

The coefficient of thermal expansion along the *a*-axis, α_a, was calculated by differentiating the above expression for a_t. The result is as follows:

$$\alpha = 8{\cdot}12 \times 10^{-6} + 46{\cdot}47 \times 10^{-11}\ t\ {}^\circ\text{C}^{-1}.$$

Following the procedure suggested by Deshpande and Mudholkar,[13] α_c was evaluated at different temperatures. Its temperature dependence can be represented by the following equation:

$$\alpha_c = 19{\cdot}59 \times 10^{-6} + 3{\cdot}77 \times 10^{-9}\ t + 28{\cdot}88 \times 10^{-12}\ t^2\ {}^\circ\text{C}^{-1}.$$

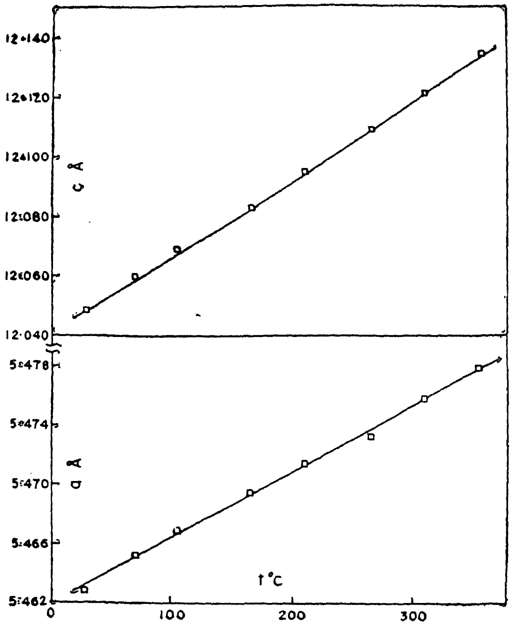


FIG. 1. Temperature variation of the lattice parameters of $PbWO_4$.

The mean coefficients of expansion in the temperature range 28°-355° C come out as $\bar{\alpha}_a = 8{\cdot}51 \times 10^{-6}/°C$ and $\bar{\alpha} = 21{\cdot}68 \times 10^{-6}/°C$. Argyle and Hummel[14] have studied the thermal expansion of $PbWO_4$ using a silica dilatometer and reported percentage linear expansion of a polycrystalline sample. No comparison is made with their results as they have not reported the directional coefficients of expansion. The nature of the anisotropy in the thermal expansion of this crystal is the same as observed in other crystals of the scheelite group, namely $\alpha_c > \alpha_a$ at all temperatures[1-6].

The authors wish to thank Dr. W. S. Brower of the National Bureau of Standards, Washington, for supplying the sample used in the investigation.

Physics Department, V. T. DESHPANDE.
College of Science, S. V. SURYANARAYANA.
Osmania University, Hyderabad-7,
July 28, 1971.

---

1. Deshpande, V. T., Pawar, R. R. and Suryanarayana, S. V., *Curr. Sci.*, 1967, **36**, 513.
2. —, Suryanarayana, S. V. and Pawar, R. R., *Acta Cryst.*, 1968, **24 A**, 398.
3. — and —, *J. Matls. Sci.*, 1969, **4**, 845.
4. — and —, *J. Appl. Phys.*, 1970, **41**, 422
5. — and —, *J. Phys. Chem., Solids*, 1969, **30**, 2481.
6. — and —, *Curr. Sci.*, 1969, **38**, 489.
7. Sirdeshmukh, D. B., *Ph.D. Thesis*, Osmania University, 1963.
8. Vegard, L. and Refsum, A., *Neues Jahrbuch Mineral*, 1928, **1**, 207.
9. Aanerud, K., *Avh. Norske. Vid. Akad. Oslo. Nr.*, 1931, **13**, 1.
10. Sillen, L. G. and Nylander, A. L., *Arkiv. Kemi. Geol.*, 1943, **17 A**, 4.
11. Swanson, H. E., Gilfrich, N. T. and Cook, M. I., *N.B.S. Monograph*, 1957, **25**, 34.
12. Jette, E. R. and Foote, F., *J. Chem. Phys.*, 1935, **3**, 605.
13. Deshpande, V. T. and Mudholkar, V. M., *Indian J. Phys.*, 1961, **35**, 434.
14. Argyle, J. F. and Hummel, F. A., *J. Amer. Ceram. Soc.*, 1963, **46**, 10.

CRYSTAL STRUCTURE OF ANTIPYRINE

As part of a systematic study,[1] using physical techniques, of some analgesic molecules and their interaction, a preliminary report on the crystal structure of antipyrine is presented here. 1-Phenyl-2, 3-dimethyl-5-pyrazolone, commonly known as antipyrine, is one of the three best known compounds in the family of pyrazole derivatives which are used as pain-relieving medicines.

The compound crystallizes in the monoclinic space group $C_{2/c}$ with a tetramolecular unit cell of dimensions $a = 16 \cdot 919$, $b = 7 \cdot 425$, $c = 17 \cdot 796$ Å and $\beta = 117 \cdot 03$ Å[1]. The X-ray diffraction data were collected upto a sin θ limit of 0·966 on a Hilger Watts four circle diffractometer belonging to Professor Dorothy Hodgkin, Oxford, using Cu Kα radiation from a cylindrical specimen of mean radius 0·35 mm, cut and ground along the b-axis. The data were corrected for Lorentz and polarisation factors, but not for absorption ($\mu = 6 \cdot 75$ cm^{-1}; $\mu r = 0 \cdot 24$) as it was considered to be negligible. The initial scale and the overall temperature factor were estimated from Wilson's statistics.

The structure was solved by the symbolic addition procedure[2]. Normalised structure factors were calculated from the scaled and the temperature corrected data using the relation

$$E^2_{\vec{h}} = F^{2h}_{\rightarrow} \Big/ \mathcal{E} \sum_{j=1}^{N} f^2_{j\vec{h}}$$

where $\mathcal{E} = 2$ for *hol* and *oko* reflections and $\mathcal{E} = 1$ for others. Two reflections with large E values and large number of interactions were chosen to fix the origin of the doubly primitive unit cell. In addition, six other reflections were assigned symbolic signs. The symbolic addition procedure, from this starting set, using the sign-determining formula

$$SE_{\vec{h}} \sim S \sum_{k} E_{\vec{k}} \, E_{\vec{h}-\vec{k}}$$

yielded a unique set of signs for 137 reflections with $E > 1 \cdot 8$. The subsequent E-map revealed all the non-hydrogen atoms in the molecule except the methyl carbon attached to the nitrogen atom in the pyrazolone ring. A three-dimensional Fourier synthesis phased on these atoms (Fig. 1) yielded the position of the methyl carbon also. Structure factor calculations with these positions and an overall temperature factor of 3·5 Å^2 gave an R value of 36% for 1,771 observed reflections. The R value was reduced to 17·31% in two cycles of isotropic structure factor least squares refinement. The positional and thermal parameters used in the last cycle are given in Table I.

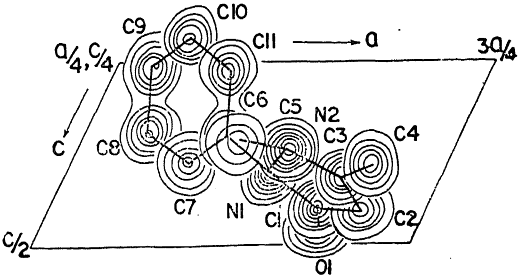


FIG. 1. Superimposed sections of the Fourier synthesis, seen along the b-axis, phased on all atoms except C5. Contours are at arbitrary but constant intervals. Atomic positions are also indicated.

TABLE I

Positional and thermal parameters

Atom	x	y	z	B
O1	0·61313	0·14352	0·47398	3·83
N1	0·51495	0·37229	0·39939	2·95
N2	0·52353	0·54134	0·36744	3·25
C1	0·59964	0·30015	0·44535	3·20
C2	0·66358	0·44143	0·45368	3·30
C3	0·61291	0·58142	0·40638	2·90
C4	0·64525	0·76245	0·39106	3·85
C5	0·45860	0·67806	0·35559	4·20
C6	0·43781	0·[illegible]6661	0·35026	3·05
C7	0·40705	0·15000	0·39029	3·30
C8	0·33146	0·04165	0·34302	3·85
C9	0·29303	0·04480	0·25401	3·43
C10	0·32607	0·16609	0·21291	3·45
C11	0·40051	0·27795	0·26082	3·35

The bond lengths and bond angles in the structure are normal. The phenyl and the pyrazolone rings in the molecule are planar and the gross molecular features are similar to those observed in some metallic complexes of antipyrine[3]. However, there are some significant differences, the most important of which pertains to the hybridization state of the two hetero nitrogen atoms in the five-membered ring. In the metallic complexes, the disposition of bonded atoms around the nitrogens is nearly planar whereas in the free molecule it is pyramidal with the N1-C6 and the N2-C5 bonds trans to each other.

Further refinement of the structure is in progress. The details of the analysis and the full results will be presented elsewhere.

The author thanks Professor Dorothy Hodgkin for making her four-circle diffractometer available to him and Dr. Kalyani Vijayan for discussion on symbolic addition procedure.

Department of Physics, M. VIJAYAN.
Indian Institute of Science,
Bangalore-12, *July* 31, 1971.

---

1. Vijayan, M., *Curr. Sci.*, 1971, **40**, 262.
2. Karle, J. and Karle, I. L., *Acta Cryst.*, 1966, **21**, 849.
3. Vijayan, M. and Viswamitra, M. A., *Ibid.*, 1968, **24 B**, 1067.

DEVONIAN FOSSILS FROM THE LESSER HIMALAYAN ZONE OF CENTRAL BHUTAN

THE present note records the occurrence of Devonian fossils from the Lesser Himalayan Zone of Central Bhutan. The fossiliferous locality was discovered by Prof. A. Gansser during geological investigations in that area and he was kind enough to send a few photographs to the author for identifications. The fossiliferous locality lies in the Tangchu basin and the rocks exposed in this basin form part of Tangchu Series.[1]

The present note is important in that it has a bearing on the palaeogeographic and geosynclinal history of the Himalayas. Fossils discovered by Prof. Gansser are in fairly good state of preservation and include representatives of brachipods, bryozoans and crinoids. Figure 1 clearly shows a well-preserved specimen of *Atrypa reticularis, Euryspirifer* (?), *Fenestella* and part of crinoid stem. A preliminary look at the photographs shows that the brachiopods are quite similar to those described by Gupta[2,3] from the Middle Devonian rocks of Kashmir, Ladakh, Lahaul and Sipti Valleys.

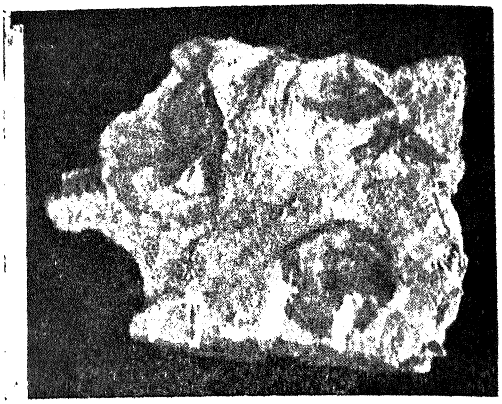


FIG. 1. Brachiopods, *Fenestella* and crinoid from the Devonian rocks of the Lesser Himalayan Zone of Central Bautan (Photo by Gansser).

The author is grateful to Prof. A. Gansser of Zurich for sending me the photographs of the specimens which he recently collected from the Lesser Himalayan Zone of Bhutan.

Centre of Advanced V. J. GUPTA.
Study in Geology,
Panjab University,
Chandigarh, *May* 5, 1971.

---

1. Gansser, A., *Geology of the Himalayas*, Interscience Publishers, London, 1964, p. 205.
2. Gupta, V. J., *Res. Bull.* (*N. S.*), Panj. Univ., 1970, **21**, 1.
3. —, *Publ. Cent. Adv. Stud. Geol.*, Panj. Univ., 1971, **9**, 46.

LOCALIZED PROGESTATIONAL ENDOMETRIAL REACTION IN THE UTERUS OF THE INDIAN FRUIT-BAT, *ROUSETTUS LESCHENAULTI* (DESMARET)

CERTAIN interesting peculiarities in the reproductive habits of the Indian fruit-bat, *Rousettus leschenaulti*, have been reported earlier (Gopalakrishna, 1964, 1969). This bat is unique in several respects. It breeds twice a year in quick succession, and successive pregnancies alternate between the two cornua of the uterus. It was shown (Gopalakrishna, 1969) that the alternation of the two ovaries in producing the mature follicle during successive breeding cycles is due to the fact that a large corpus luteum almost completely filling the ovary persists until mid-gestation of the following pregnancy.

A large number of females of *Rousettus leschenaulti* carrying very early stages of pregnancy were obtained during the early part of the breeding season. The cranial part of the uterine cornu of the prospective pregnant side becomes markedly swollen immediately after ovulation, and becomes progressively enlarged during the tubal journey of the egg. The examination of the sections of such uteri showed that the uterine cornu undergoes profound progestational changes in a very small segment of the uterus near its cranial end even before the blastocyst reaches the uterus. In this region of the uterus the uterine lumen has enlarged, the epithelium of the uterus has become tall and the cells have become vacuolated, the glands have increased in length and have become coiled and the lumina of the glands contain secretion. The endometrium shows a distinct edema, which is characteristic of progestational reaction. On the other hand, the middle and the caudal regions of the uterus do not show such progestational reaction. Further, the examination of the uteri of specimens carrying early stages of implantation reveals that the blastocyst implants at the cranial end of the uterus in a pre-formed implantation chamber.

The question that would necessarily arise concerns the mechanism by which only a small segment of the uterus is activated to undergo progestational changes. It is evident that progesterone secreted by the corpus luteum has to be supplied to a part of the uterus only. Marshall (1953) indicated that in the fruit-bat *Pteropus giganteus*, there is a distinct connective tissue isthmus between the ovary and the uterus of the respective side, and progesterone may be carried to the respective uterine cornu through this connective tissue isthmus. This results in unilateral progestational reaction in this animal. Gopalakrishna and Murthy (1960) demonstrated the presence of a portal system between the ovary and the uterus of the corresponding side in *Cynopterus sphinx gangeticus* and *Taphozous longimanius*, and postulated that the flow of progesterone is short-circuited into the respective uterine cornu through the portal vessel. *Rousettus leschenaulti* is unique in showing progestational endometrial reaction in an extremely localized region at the cranial end of the uterus. The exact mechanism by which this is brought about in this animal is not known.

Dept. of Zoology, A. GOPALAKRISHNA.
Institute of Science, (MISS) K. B. KARIM.
Nagpur, *May* 24, 1971.

---

1. Gopalakrishna, A., *Curr Sci.*, 1964, **33**, 558.
2. —, *Ibid.*, 1969, **38**, 388.
3. — and Murthy, K. V. R , *Bull. Zool. Soc., Coll. Sci., Nagpur*, 1960, **3**, 19.
4. Marshall, A. J., *Jour. Endocrinol.*, 1953, **9**, 42.

ON THE VARIATION OF LIMNOBIOTIC CONDITIONS ALONG A HOT SPRING THERMAL GRADIENT

No information is available on the species composition of biota along any hot spring thermal gradient in India, though a few workers[1-5] have reported the systematics of thermal algae without any ecological interpretation earlier. Jana[6] and Jana and Sarkar[7,8] have recently investigated the limnological and bacteriological characteristics of some of the thermal springs of West Bengal and Bihar. The present communication describes the variation of planktonic composition as well as chemical factors along a hot spring thermal gradient in Tantloi, Bihar.

All results reported here were obtained on hot springs of Tantloi, Santal Parganas, Bihar. Two thermal springs enclosed by cemented cisterns, 2 × 1 × 0·7 meters, are located in the bed of one of the channels of the main river. It bubbles continuously at the orifice. The hot springs occur in the region of Rajmahal Hills and their outflow has been estimated as 5,000 gallons/hour. The excess water flows out through a single channel about 0·75 meter wide and one meter deep which flows east. The channel gradually widens and bends several times and eventually spreads out into a marsh which also receives the overflow of the main river.

Five locations with temperature ranges of 44° C, 41·5° C, 40° C, 37·5° C and 35° C, along a hot spring thermal gradient, were selected for the present study, which was carried out in summer 1969. The physico-chemical variables were determined according to the Standard Methods.[9]

Temperature of these thermal springs is often remarkably constant at the source. As the water runs away from the source, the temperature falls down gradually and the rate of cooling is a function of initial temperature, channel dimensions and volume of water. The variation in the wind speed is more important than the atmospheric temperature in affecting the cooling rate.[10]

Table I shows all the readings of physico-chemical variables and biological characteristic taken for each station. The pH and carbonate alkalinity diminished gradually as the run-off water cooled down. Possibly the loss of alkalinity is due to decompositon of leaves falling from neighbouring trees on the bottom of the channel. This change in pH, of course, is merely an index of the occurrence of other changes in the chemical nature of each station. The bicarbonate alkalinity, however, progressively increased with the distance of the effluent. Since carbonate and bicarbonate alkalinity itself is inversely related, the fall of CO_3^{--} will cause HCO_3^- to rise.

TABLE I

Variations in the physico-chemical conditions and biotic composition at different temperatures of the effluent channel

Variables	44° C	41·5° C	40° C	37·5° C	35° C
pH	9·40	9·30	9·20	9·00	8·90
Carbonate alkalinity ($CaCO_3$) ppm	53·00	51·00	50·00	46·00	44·00
Bicarbonate alkalinity ($CaCO_3$) ppm	179·00	181·00	183·00	192·00	188·00
Free CO_2 ppm	Nil	Nil	Nil	Nil	Nil
Chloride ppm	58·00	52·00	58·00	56·00	56·00
Dissolved oxygen ppm	8·00	6·80	6·40	6·00	4·80
Name of the biota/litre					
Oscillatoria terebriformis	28	27	34	27	4
Navicula cincta	8	41	37	769	1050
Cyclotella sp.	7	18	3	21	100
Cosmarium sp.	..	..	..	2	..
Merismopedia sp.	..	..	..	..	1
Anabaena sp.	..	..	..	..	2
Spirogyra sp.	..	7	2	6	1
Cyclops sp	..	..		9	1
Nauplius larva	..	..	..	2	1
Chironomous larva	..	..	..	1	..
Cypris sp.	..	..	..	3	3
Lecane sp.	..	..	..	..	1
Tobrilus vibratus	..	..	2	1	1

No significant variation was observed with regard to chloride. Dissolved oxygen steadily diminished as the run-off water flows away from the source. A plausible explanation is that the rate of outflow is reduced at the down stream which can absorb little atmospheric oxygen at the water-air interface. Moreover, the decomposition of neighbouring leaves may reduce the oxygen value substantially at the down stream.

A notable feature of the algal community was the preponderance of Cyanophyceae in the thermal gradient, typical of thermal streams and hot spring pools throughout the world. *Oscillatoria terebriformis*, presumably with the highest temperature tolerance, occurred profusely closest to the source and were encountered from 44° C to 35° C—approximately 500 meters from the source. Here, *Navicula cincta* and *Cyclotella* sp. became the dominant form and *Oscillatoria* was no longer a major group. *Navicula cincta* were attached by gelatinous secretions to the algal filament

Cosmarium sp., *Merismopedia* sp. and *Anabaena* sp. were not observed in the effluent channel until the water temperature declined to 37·5-35° C. *Spirogyra* sp. appeared at 41·5° C and were present upto 35° C, being irregular at different temperatures.

The occurrence of animal life, *viz.*, *Tobrilus vibratus* was not noted in the effluent until the hot water got sufficiently cooled down to 40° C. *Cyclops* sp. and their nauplii attained greatest density at 37·5° C and thereafter almost disappeared.

Undoubtedly, a number of biotic and abiotic factors interact to produce the distribution of biota along a hot spring thermal gradient. The warm water and the formidable ionic concentrations tend to reduce the member of species. Thus, Stockner[11] found only 10 diatom species at 36° C and 29 species at 4° C. The variation in the temperature tolerance among the different species is invariably a factor which explains the lack of uniformity in distribution. Castenholz[12] pointed out that specific differences in growth temperature optima may result in distinct species band covering different portions of the gradient. Another factor may be the interspecific competition of space among biota along such a thermal gradient.

Dept. of Zoology, B. B. JANA.
Visva-Bharati University, H. L. SARKAR.
Santiniketan, West Bengal,
India, *June* 25, 1971.

---

1. Drouet, F., *Trans. Am. microsc. Soc.*, 1938, **57**, 127.
2. Gonzalves, E., *J. Univ. Bombay*, 1947, **16**, 22.
3. Prasad, B. N. and Srivastava, P. N., *Proc. Nat. Inst. India*, 1965, **31 B**, 45.
4. Thomas, J. and Gonzalves, E. A., *Hydrobiologia*, 1965, **25**, 330 ; **26**, 21.
5. Vasisht, P. C., "Thermal Cyanophyceae of India," *Ph.D. Thesis*, University of Panjab, Chandigarh, India, 1967.
6. Jana, B. B., "On the study of limnology and bacteriology of the thermal springs of Bakreswar," *Ibid.*, Visva-Bharati University, Santiniketan. India, 1970
7. — and Sarkar, H. L., *Hydrobiologia*, 1971, **37**, 33.
8. — and —, *Jour. Asiatic Soc. Sci.* (In press).
9. American Public Health Association. *Standard Methods for the Examination of Water and Waste Water*, 12th Ed., APHA, 1965, p. 769.
10. Brock, T. D., *Nature*, 1967, **214**, 882.
11. Stockner, J. G., *Limnol. Oceanogr.*, 1967, **12**, 13.
12. Castenholz, R. W., *Bacteriol. Rev.*, 1969, **33**, 476.

A LARGE-SIZED NEW SPECIES OF AMOEBA, *AMOEBA NAVINA* SP. NOV FROM TROPICAL RIVERS

THIS laboratory has been successful in cultivating a new species of large-sized amoeba, *Amoeba navina* sp. nov. collected from Mula-Mutha Rivers since 1967. The amoeba is visible to the naked eye. It ranges in length from 0·5 mm to 0·9 mm. However, as large as 1·2 mm sized forms have been noticed in petri dish cultures.

This new species, *Amoeba navina* sp. nov., has a distinct limiting membrane, hyaline ectoplasm and dark endoplasm. The latter contains numerous small spherical elongated vesicles. These vesicles appear dark in subdued illumination under the low power of the microscope. Besides these vesicles, the endoplasm also includes numerous food vacuoles, clear vesicles, single water expulsion vesicle and single spherical, oval or elongated polymorphic nucleus, lacking an endosome. Less than 1% population of *A. navina* sp. nov shows binucleate condition, representing one of the stages of binary fission. Pseudopods are distinctly tubular, lobose and have clear tips. During normal locomotion, the amoeba shows one or two blunt pseudopods which determine the direction of its movement. The remaining pseudopods, when present, are either stationary or retracting. For quick unidirectional locomotion, the amoeba gives out only one pseudopod. Such a monopodal form of *A. navina* appears club-shaped; the blunt end being in the direction of locomotion. In unfavourable medium, these amoebae become thin, elongated and give out long 6 to 12 tubular pseudopods and the whole structure resembles a twig, or a branch of a tree.

A. navina feeds voraciously and favours Paramoecia as food. It also takes Rotifers, Chilomonas, Tetrahymena, Colpidia, Vorticella, eggs of worms, Arcella, as well as smaller amoebae of species other than its own.

Amoeba navina sp. nov. has been maintained in modified petri dish cultures during the last 3½ years. These amoebae were found to be comfortable between 16° C and 39° C carrying out all the vital functions of life, including feeding and fission. Curiously indeed they have survived the heat wave of May 1970, when amoeba medium temperature rose to 41° C! So also they have lived through the cold wave during the winter of 1970, when amoeba medium temperature dropped to 16° C.

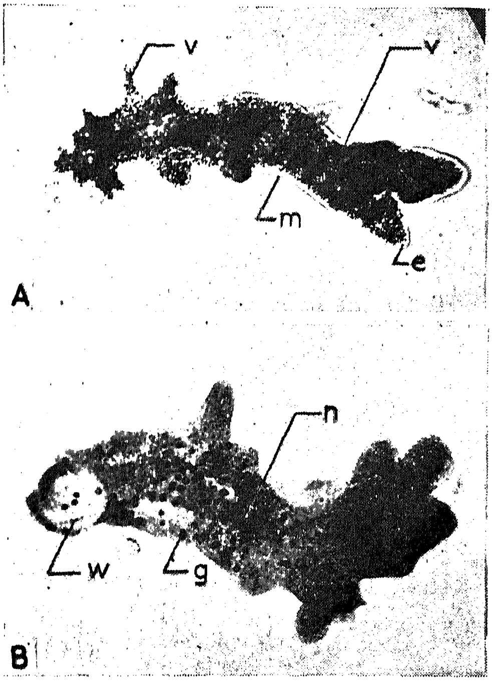


FIG. 1. A. *Amoeba navina* sp. nov., a living specimen during normal mode of locomotion, showing clear ectoplasm (*e*), outer membrane (*m*), and the dark endoplasm containing numerous small visicles (*v*). Subdued ligh photomicrograph, × 130. B. *A. navina* sp. nov.—Hematoxylin and eosin stained preparation showing nucleus (*n*), granules (*g*), and water expulsion vesicle (*w*), × 130,

This amoeba has certain similarities with *A. nitida* (Penard[1]), *A. proteus* and *Chaos carolinensis*.[2] Like other Amoebidae, *e.g.*, *Amoeba proteus, A. nitida,* it possesses clearly defined ectoplasm, granular endoplasm and tubular pseudopods with clear caps for locomotion. *Amoeba navina* sp. nov. happens to be the largest mononucleate form among Amoebidae known so far. Superficially it looks like the multinucleate form, *Chaos carolinensis* in respect of size, its feeding habits, general structure and formation of pseudopods, but differs from the latter in respect of possessing single nucleus, its ability to withstand tropical temperature variations and the lack of endoplasmic crystals. On the other hand, the largest mononucleate forms known so far are *Amoeba nitida* (Penard[1]) and *A. proteus*; both found in freshwaters. These are smaller than *A. navina* sp. nov. *A navina* always gives out either one or two functional pseudopods at a time, while *A. nitida* shows three principal pseudopods. In monopodal forms, *A. navina* sp. nov. has a blunt end in the direction of it's locomotion, while *A. nitida* has pointed tubular end in the direction of monopodal locomotion. *A. nitida* possesses narrow truncated bipyramidal crystals in independent vesicles. Such crystals are lacking in *A. navina* sp. nov.

The branched structure of *A. navina* giving out several slender, tubular pseudopods is the unique characteristic. Its fairly large, mononucleate structure showing lack of crystals in it's endoplasm, and its ability to withstand tropical temperature variations between 16° C and 41° C, are the principal characters which have led to the classification of this animalcule into a new species, *Amoeba navina* sp. nov.

This one-celled large animalcule is also easy to cultivate and maintain in tropical laboratories. This makes it an ideal material for routine class work and cell biological research.

I am grateful to Professor Eugne Bovee for useful suggestions and for sending copies of his manuscript under publication[2] for my reference.

Research Divn., NAVANIT LAXMAN SHAH.
Biotech. Laboratories,
759/89, Bhandarkar Institute Road,
Poona-4 (India), *January* 1, 1971.

---

1. Penard, E., *Faune Rhizopodugue du Bassin du Léman. Kundig*, Geneve, 1902, p. 61.
2. Bovee, E. C., M/S. on "the identification of lobose rhizopods," in: *A Handbook on the Identification of Protozoa*. Ed. Lee. J. J. in preparation—a personal communication, 1969.

CELLULOSE POWDER AS LEGUME INOCULANT BASE

PEAT is the preferred carrier material in the manufacture of legume rhizobia inoculants. Superiority of peat over other carrier materials is due to (*i*) high protection it offers to the culture against high storage temperature, (*ii*) low moisture loss during storage, and (*iii*) the presence of certain essential nutrients which not only help survival of the organism but also support further multiplication during storage.

High-grade peat is not available in India but only small deposits of low-grade peat occur in the Nilgiri Hill ranges[1]. Initial studies carried out by Iswaran *et al.*[2] indicate that Indian peat could be satisfactory as inoculant-base.

In our preliminary comparative studies on suitability of soil, of coconut-shell powder and cellulose powder as substitutes for peat, cellulose powder appeared to be promising both from the point of view of the survival of rhizobia and the ease with which the seed could be treated. As an extension to these studies, survival of rhizobia in the inoculant during storage and on the treated seed, and the adequacy or otherwise of the surviving number to induce nodulation in legume roots were examined.

Soyabean-specific *Rhizobium* strain S-12 from the collection of the Department of Microbiology, University of Agricultural Sciences, Bangalore, was used in these studies. Four-day-old yeast-extract mannitol agar grown bacterial cells were suspended in sterile water containing 0·1% carboxyl methyl cellulose and the suspension was mixed with sterile cellulose powder of 200 mesh fineness. The inoculant powder thus prepared was divided into 12 lots and sealed in polythene bags. One set of six bags was stored at refrigeration temperature of 10° C and the other lot of six was stored at room temperature (28°–30° C). Inoculant samples were withdrawn at periodical intervals of six days over a period of 24 days and the surviving number of rhizobia was determined by dilution-plate-count method using yeast-extract-mannitol-congo-red agar. A portion of the sample withdrawn was used to treat the soyabean seed (variety Hill). The seed was moistened with water, rolled in the inoculant powder and was dried in shade for about 15 minutes. The number of rhizobia per treated seed was determined by washing five treated seeds in an aliquot of sterile water and plating appropriate dilutions of the latter in yeast-extract-mannitol-congo-red agar. At the same time one portion of the treated seed was planted in pots containing sterile sand. The pot-cultured plants were examined for nodulation at the end of six weeks.

The data on surviving rhizobia in the inoculant powder and the number per treated seed are presented in Tables I and II, respectively. During the first three days of storage the number fell to about half the initial number in the samples stored at 10° C and more than half in the ones stored at 28°–30° C. During the subsequent period upto 24 days there was a drastic fall in the surviving number but yet the number was high enough to induce effective nodulation. The moisture content in the inoculant fell from its original 70% to about 40% both in the samples stored at 10° C and at 28–30° C. Correspondingly, the number of rhizobia per treated seed was also reduced.

TABLE I

Population of surviving rhizobia in the inoculum (on moisture-free basis)

Interval in days	Stored at 10° C		Stored at 28–30° C	
	Surviving cells (10^6/g)	Moisture %	Surviving cells (10^6/g)	Moisture %
0	506·154	70	506·154	70
3	241·104	50	140·434	43
6	36·461	47	18·581	42
12	2·957	45	2·862	42
24	2·125	45	1·429	40

TABLE II

Population of rhizobia in treated seed at different intervals

Interval in days	Stored at 10° C	Stored at 28–30° C
	Population (10^6/seed*)	Population (10^6/seed*)
0	2·875	2·875
3	2·575	1·615
6	0·422	0·215
12	0·035	0·032
24	0·025	0·017

* Average of five treated seeds.

The plants examined six weeks after planting exhibited uniform nodulation irrespective of whether the seed was treated with zero-day or 24-day old inoculant. The wet weight of nodules per plant ranged from 0·2 to 0·4 g.

Peat-base inoculants containing initially 10^8 rhizobia per gram were observed to give on an average 73,000 rhizobia per treated soyabean seed[3]. In the present study 24-day-old inoculant containing 2 × 10^6 rhizobia per gram gave about 25,000 rhizobia per treated seed. For effective nodulation of soyabean roots under favourable conditions, more than 1,000 rhizobia per treated seed are said to pe essential[3]. In other cases the required number may vary from as few as 50 to several thousands per treated seed[4]. Considering this, 25,000 rhizobia obtained per treated seed could be considered as more than adequate for inducing nodulation.

Death rate of rhizobia noted during the first three days of storage appeared to be proportionate to the moisture loss. But during the subsequent period moisture content of the inoculant remained fairly constant yet there was drastic reduction in the number. Commercial peat-base inoculants are prepared by mixing the whole broth culture of rhizobia with peat. As such, these inoculants not only show high survival of rhizobia but also support further increase in number during storage[5]. In the present case the inoculant was prepared by mixing the suspension of agar-grown cells with cellulose powder. Much better survival could be expected if cellulose-base inoculants were to be prepared with whole broth culture of the organism. As it is, cellulose powder appeared to be satisfactory inasmuch as it gave the same ease of handling and low moisture loss as peat-base inoculant and fairly high survival of rhizobia.

In acetate factories cotton linter-pulp dust which collects in the driers is discarded. This cellulose dust could be ground to pass through 200–300 mesh sieve and made use of as a carrier for legume inoculants.

The authors are thankful to Dr. G. Rangaswami, Dean, University of Agricultural Sciences, Bangalore-24, for suggesting the problem and for his interest in the studies.

Dept. of Microbiology, B. K. PUGASHETTI.
Univ. of Agri. Sci., H. S. GOPALGOWDA.
Bangalore-24, R. B. PATIL.
May 12, 1971.

---

1. Leather, J. W., *Agric. J. India*, 1909, **4**, 292.
2. Iswaran, V., Sundara Rao, W. V. B., Magu, S. P. and Jauhri, K. S., *Curr. Sci.*, 1969, **38**, 468.
3. Burton, J. C., "Rhizobium culture and use," in *Microbial Technology*, ed. H. J. Peppler, Reinhold Publishing Corpn., New York, 1967, p. 1.
4. Fred, E. B., Baldwin, I. L. and McCoy, E., *Root Nodule Bacteria and Leguminous Plants*, Univ. of Wisconsin, Madison, 1932, p. 1.
5. Vincent, J. M., "Environmental factors in the fixation of nitrogen by the legume" in *Soil Nitrogen.* Ed. Bartholomew, W. V. and Clark, F. E., American Society of Agronomy, Madison, Wisconsin, U.S.A., 1965, p. 384

LIGNITE AS A CARRIER OF RHIZOBIA

The importance of seed inoculation of rhizobia to increase the yields of leguminous crops is well known[1]. Soil rich in organic matter is being used in our country for the preparation of legume inoculants. Iswaran *et al.*[2] have suggested the use of Indian peat as a carrier of *Rhizobium* spp. because of its high organic matter content, aeration and water-holding capacity. The present investigation was undertaken to study the possibility of using lignite as a carrier for *Rhizobium* spp. Lignite which is being continuously mined from extensive deposits by Messrs. Neyveli Lignite Corporation Ltd. at Neyveli in Tamil Nadu was used in the present study. The organic matter content of the lignite was 73·2 to 76·9% and the pH was 3·8.

The lignite was dried, powdered and sieved through 72 mesh sieve. The pH was adjusted to 7·0 with 10% $CaCO_3$ solution, and was distributed in 50 g quantities into bottles and sterilized for one hour at 20 psi. An efficient strain of Rhizobium sp., isolated from the root nodules of peanut (*Arachis hypogea* L.) was inoculated into 250 ml Erlenmeyer flasks each containing 100 ml quantities of yeast-extract-mannitol medium and was grown for four days at room temperature on a rotary shaker. At the end of the incubation period 20 ml of inoculum was aseptically added to the sterilized lignite and the water-holding capacity was adjusted to 40%. The bottles were incubated upto three weeks at 28 and 35° C. In another set of bottles, the lignite was amended with 1% soybean powder. The bacterial population was estimated at weekly intervals by the dilution plate technique using yeast-extract-mannitol agar containing Congo red[3,4].

The results obtained have clearly revealed that *Rhizobium* sp. multiplied well in lignite. The growth of *Rhizobium* sp. inoculated was much better at 28° C than at 35° C. The highest bacterial count obtained in the lignite culture was $13 \cdot 14 \times 10^8$ which is much superior to the highest count of $1 \cdot 0 \times 10^8$ reported in soil culture[2]. The highest count in the lignite could be increased to $19 \cdot 15 \times 10^8$ by amending it with 1% soybean powder (Table I).

Peanut seeds were surface-sterilized with 0·1% mercuric chloride washed repeatedly with sterile water, pretreated with inoculated lignite and sown in sterile and unsterile soils in pots. Pots sown with surface-sterilized uninoculated seeds, served as control. Increase in growth, total nitrogen and number of nodules was observed in the plants raised from inoculated seeds compared to the control (Table II).

Table I

Survival of peanut rhizobia in lignite

(Population in 10^8/g of moisture free lignite)

Incubation period (days)	Lignite		Lignite+1% soybean powder	
	28° C	35° C	28° C	35° C
0	6·27	6·27	6·27	6·27
7	10·27	9·11	14·89	10·92
14	13·14	10·76	18·72	12·46
21	13·14	9·45	19·15	13·17

Table II

Effect of pre-treatment of seeds with lignite inoculated with Rhizobium *sp. on the growth, total nitrogen and nodulation of groundnut plants (On 40th day)*

Seed treatments	Sterile soil			Unsterile soil		
	Growth* (in inches)	Total nitrogen†	Number of nodules per plant*	Growth* (in inches)	Total nitrogen†	Number of nodules per plant*
1. Inoculated with *Rhizobium* sp. in lignite	4·4	4·47	14	4·8	4·96	18
2. Uninoculated	3·9	3·62	..	4·1	4·32	9

* Average of ten plants † g/100 g on oven dry basis.

The result of this investigation suggests that lignite could be used as a carrier material for the *Rhizobium* spp.

Microbiology and
Plant Pathology Section,
Faculty of Agriculture,
Annamalai University,
Annamalainagar P.O.,
Tamil Nadu, *May* 16, 1971.

R. Kandasamy.
N. N. Prasad.

---

1. Rangaswami, G. and Oblisami, G., *J. Annamalai Univ.*, 1961, **23 B**, 119.
2. Iswaran, V., Sundara Rao, W. V. B., Magu, S P. and Jauhri. K. S, *Curr. Sci*, 1969, **38** (9), 468.
3. Fred, E. B., Baldwin, I. L. and McCoy, E, *Root Nodule Bacteria and Leguminous Plants*, Univ. of Wisconsin Studies on Science, 1932, No. 5
4. Hahn, N. J., *Can. J. Microbiol.*, 1956, **12**, 725.

NATURE OF GALL MIDGE RESISTANCE IN RICE

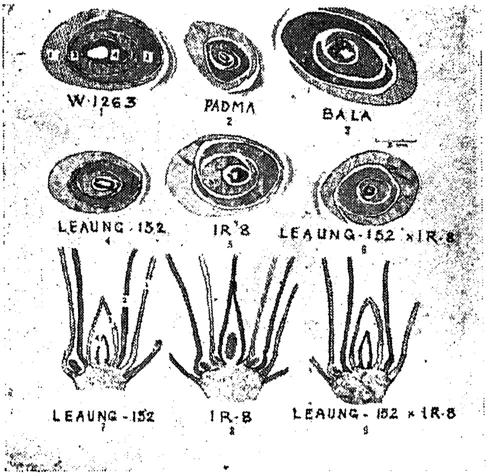
THE maggots of the rice gall midge [*Pachydiplosis oryzae* (W-M) Mani] penetrate to the developing primordium of the rice plant by wriggling down through the enveloping whorls of the leaf-sheaths. In the primordium, they feed and develop on the tender leaf-sheath leaf-blade tissues, with the result that the free margins of the leaf-sheaths become glued in the form of a hollop, long tubular gall or silver shoot. Affected tillers do not put forth panicles and significant yield losses are caused to crops.

Rice varieties resistant to this pest have been isolated.[1] The resistance of some rice varieties to gall midge was attributed to the presence of fibrous mechanical tissues found in the leaf-sheaths.[1] The compactness of leaf-sheaths was also mentioned to be one of the characters responsible for resistance of rice varieties to gall midge.[2] Further studies were carried out to find out the exact mechanism of resistance in rice to the gall midge.

Two varieties, *viz.*, IR-8 (susceptible) and *Leaung* 152 (resistant) and the cross of *Leaung* 152 × IR-8 were infested with newly emerged maggots of the gall midge at 10 days age of the plants. Five hundred plants of each variety were infested each with five maggots, in three replications. At 26 days age of the plants, the silver shoots were counted. In the variety IR-8, 89·7% of the tillers had silver shoots while there were no silver shoots in *Leaung* 152. In the cross, the incidence ranged from 2·0% to 17·5%. Dissection of the tillers showed that the maggots had entered into the whorl of tender leaf-sheaths and had reached the primordium in the variety IR-8 (Fig. 8), while in the variety *Leaung* 152 and in the cross *Leaung* 152 × IR-8, the maggots had not penetrated beyond the axil of the outermost leaf-sheath (Figs. 7, 9).

Comparison of the transverse sections of the plants through the primordia showed that in the variety IR-8, the leaf-sheath leaf-blade parts which were four in number were adpressed and involuted leaving a relatively wide interspace (Fig. 5). In the variety *Leaung* 152, the four leaf-sheath leaf-blade parts were involuted but with little interspace between the leaf-sheaths (Fig. 4).

The habit of the maggot of the rice gall midge is to wriggle between the whorls of the leaf-sheaths and reach the primordium since it cannot bore through the tissues. The more compact the whorl, the more difficult is the penetration to the primordium. The presence of maggots could be detected in the outer leaf-axil only in resistant variety *Leaung* 152 and in the cross *Leaung* 152 × IR-8 (Figs. 7, 9). Further penetration was presumably arrested due to the compactness of the leaf-sheaths. Therefore, it is concluded that resistance for penetration of the maggots is dependent on the compactness of leaf-sheaths.



FIGS. 1–9. Figs. 1–6. Cross-sections of stems showing the inter leaf-sheath space. Figs. 7–9. Schematic longitudinal sections of stems showing the maggots *in situ*. Numbers inset leaf-sheaths. (Courtesy: Director, Central Rice Research Institute, Cuttack-6).

Two more resistant varieties, *viz.*, *W.* 1263 and *PTB.* 18 and three susceptible varieties, *viz.*, *Padma*, *Bala* and *GEB* 24 were examined to confirm the above findings and it was found that the resistant varieties were characterised with little interspace while the susceptible varieties had more interspace between leaf-sheaths, enabling the entry of the gall midge maggots to reach the primordium (Figs. 1, 2 and 3).

This investigation will be of great practical utility in the rapid screening of the genetic stocks and for the study of the inheritance of gall midge resistance in rice.

We wish to thank Dr. S. Y. Padmanabhan, Director, Central Rice Research Institute, Cuttack, for advise and encouragement in the conduct of this investigation.

Central Rice Res. Inst.,
Cuttack-6, India,
April 23, 1971.

Y. S. Rao.
P. Israel.
C. P. Yadava.
J. K. Roy.

---

1. **Anon**, *Annual Technical Report of the Central Rice Research Institute, Cuttack for the Year 1964.*
2. Roy, J. K., Israel, P. and Panwar, M. S., *Oryza.*, **1969**, **2** (6), 43.

HYDRELLIA PHILIPPINA FERINO (EPHYDRIDAE, DIPTERA) AS A PEST OF RICE IN KERALA

THE larvae of *Hydrellia philippina* Ferino were observed as a pest of rice seedlings at the Central Rice Research Station, Pattambi, in the first crop (April-May to September-October) and second crop (August-September to January-February) seasons of the year 1970-71.

Small yellowish-white maggots were observed to feed on the innermost margin of the leaves in the central whorl causing blotch-like longitudinal discolouration as the attacked leaves unfurled. The newly-opened leaves, in many cases, revealed apical drying and shrivelling consequent on larval damage. These symptoms appeared mostly on younger seedlings and disappeared as the plants approached the flag leaf stage. *H. philippina* has been earlier reported to cause similar damage to newly transplanted rice seedlings in the Philippines (Patanakamjorn, 1964; Ferino, 1967).

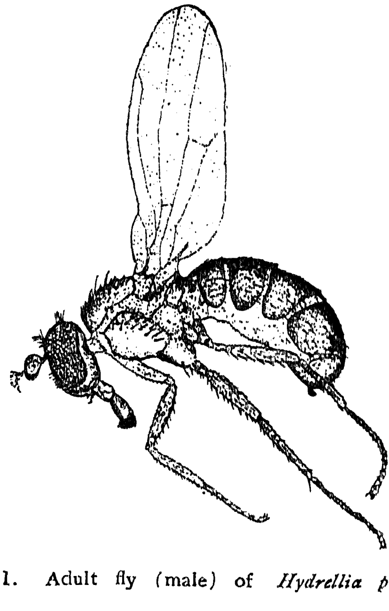


FIG. 1. Adult fly (male) of *Hydrellia philippina* Ferino.

The percentage infestation of the crop recorded at the Central Rice Research Station, Pattambi, from random samples was 20 to 30 and 10 to 20 for the first crop and second crop seasons respectively.

Adults were reared in the laboratory from pupae which were found within the leaf-sheaths of outermost tillers. The adult fly (Fig. 1) has its total body length 2·08 mm for the female and 1·85 mm for the male. Adult flies are dark-brown to greyish-brown dorsally, the lateral region being light olivaceous.

Other species of *Hydrellia* recorded as pests of rice include *H. sasakii* (Yuasa and Ishitani) (Okamoto and Koshihara, 1954) and *H. griseola* Fallen, in Japan (Kuwayama, 1956).

The authors gratefully acknowledge the help rendered by Dr. M. G. Ram Das Menon, Systematic Entomologist and Dr. V. C. Kapoor, Assistant Systematic Entomologist, Division of Entomology, Indian Agricultural Research Institute, New Delhi, for identifying the flies.

Central Rice Res. Stn.,
Pattambi,
Kerala,
May 1, 1971.

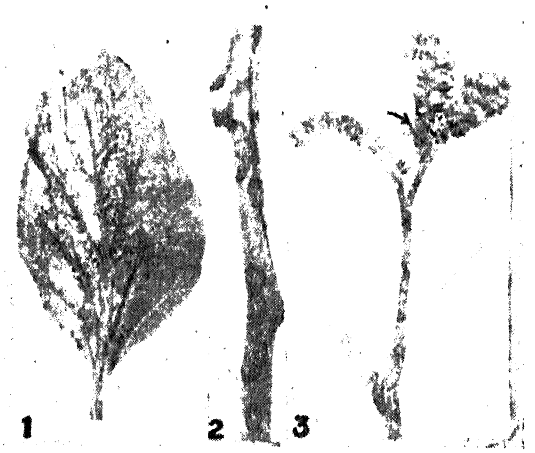
B. Thomas.
C. C. Abraham.
K. Karunakaran.
R. Gopalakrishnan.

---

1. **Ferino, M. P.**, "A new species of *Hydrellia* (Ephydridae, Diptera) on rice." *The Philippine Entomologist*, 1967, **1** (1), 3.
2. **Kuwayama, S.**, "The smaller rice leaf miner *Hydrellia griseola* Fallen in Japan," *Proc. Inter. Cong. Ent.*, 1956, **10** (3), 399.
3. **Okamoto, D.** and **Koshihara, T.**, "Notes on paddy stem maggot (*Hydrellia sasakii*) a pest of the late transplanted paddy rice," *Oyo – Kontyu.*, 1954, **10** (2), 71.
4. **Patanakamjorn, S.**, "Morphology and bionomics of the rice leaf whorl maggot", *Ann. Tech. Bull. Ent. Phytopath. Soc.*, 1964, **4**, 69.

A BACTERIAL LEAF SPOT DISEASE ON *HELIOTROPIUM EICHWALDI* DUE TO *XANTHOMONAS HELIOTROPII* SP. NOV.

IN June 1968, a bacterial leaf-spot disease was observed on *Heliotropium eichwaldi* Steud, a weed, growing in cowpea fields infected with bacterial blight (*Xanthomonas vignicola*) disease at the I.A.R.I., New Delhi. It was suspected that both the hosts might be infected by the same pathogen. In pathogenicity test, the pure culture of the bacterium failed to infect cowpea and the cowpea pathogen did not infect *H. eichwaldi.* However, on the basis of bacteriological properties, the weed pathogen was found to be a xanthomonad. Furthermore, when several plants, *viz.*, *Gossipium hirsutum* L., *Cajanus cajan* (L.) Millsp., *Phaseolus aureus* Roxb., *P. mungo* L., *P. vulgaris* L., *Glycine max* (L.) merr., *Citrus medica* Hook, *Capsicum annuum* L., *Ricinus communis* L., *Sesamum orientale* L., *Amorphophallus campanulatus* (Roxb.) Blume ex Dcne., *Cyamopsis tetragonoloba* (L.) Taub., *Ficus religiosa* L., *Pisum sativum* L., *Colocasia esculenta* L., *Dolichos lab-lab* L., *Hibiscus abelmoschus* L., *Morus alba* L., *Pedalium murex* L., and *Crotalaria junctia* L., growing in the same area and some of them reported to be hosts of *Xanthomonas* spp. were repeatedly inoculated, no infection was obtained. On *H. eichwaldi* plants watersoaked spots on leaves, stems and flowers (Figs. 1-3) appeared 6-8 days after inoculation and turned blackish-brown in time. The leaves gave blighted appearance and stem often developed splits. The pathogen, however, was not systemic. No xanthomonad has been previously reported on this host from anywhere.[1] The morphological, physiological and biochemical properties of the pathogen were, therefore, studied in detail and described below.



FIGS. 1-3. Symptoms on Leaf (Fig. 1) Stem, (Fig 2) and Inflorescence from artificially inoculated plants (Fig. 3).

The bacterium was rod-shaped, occurring singly or in pairs, gram-negative, non-capsulated, non-spore-forming, non-acid-fast and motile with a single polar flagellum. On nutrient agar colonies were circular, convex, glistening, yellow and produced slime.

It was stricaly aerobic; utilised glucose oxidatively; hydrolysed starch; liquefied gelatin; produced ammonia, H_2S, catalase but not indole, acetoin and urease; did not reduce nitrate; did not utilise asparagine as a sole source of carbon and nitrogen; turned milk alkaline and peptonised it without coagulation; reduced litmus; gave negative methyl red test; growth was retarded by 2% and suppressed by 3% NaCl; produced acid without gas from mannose, sucrose, glucose, dextrin, galactose, arabinose, cellobiose, trehalose, fructose, xylose, glycogen, raffinose, melibiose, mannitol and ribose but not from *meso*-erythrit, rhamnose, adonitol, dulcitol, inositol, inulin, sorbose, salicin and lactose; and utilized sodium propionate and succinate but not oxalate and tartrate.

Till a widely accepted criteria for speciation in the genus *Xanthomonas* is evolved,[2-4] the bacterial leaf-spot pathogen of *H. eichwaldi* is proposed as a new species *X. heliotropii* sp. nov. following the current practice of considering its host specificity.

We are thankful to Dr. S. P. Raychaudhuri, Head, Division of Mycology and Plant Pathology, for encouragement and providing the facilities, and to Shri H. K. Gorkha for the photography.

Div. of Mycol. and
Plant Pathology,
Indian Agric. Res. Inst.,
New Delhi-12, *March* 29, 1971.

J. K. JINDAL.
P. N. PATEL.

---

1. Breed, R. S., Murray, E. D. G. and Smith, N. R., *Bergey's Manual of Determinative Bacteriology*, Williams and Wilkins Co., Batimore, 1957, 7th ed., p. 1094.
2. Dye, D. W., *N. Z. J. Sci.* 1966, **9**, 843.
3. Stolp, H and Starr, M. P., *Phytopath. Z.*, 1964, **51**, 442.
4. —, —. and Baigent, N. L., *Annu. Rev. Phytopathol.*, 1965, **3**, 231.

ANTHOCYANIN DEVELOPMENT *IN VITRO* IN TENDER INTERNODE EXPLANTS OF *EUCALYPTUS*

WITH the object of studying the morphogenetic response, colourless internode explants of *Eucalyptus citriodora*, 3 × 3 mm in size, were cultured *in vitro* on Nitsch[1] basic medium, supplemented with 2% sucrose, 2 ppm indole acetic acid, 1 ppm kinetin, 1000 ppm casein hydrolysate and 1000 ppm yeast extract. The medium was solidified with 0·7% Bacto (Difco) agar and the pH was adjusted to 6. The cultures were kept in dark for c 15 days before being exposed to continuous fluorescent light in order to get new cambia cut. The explants gave rise to masses of undifferentiated coloured tissue, which after 5-6 weeks of inoculation, transformed into characteristic flat disc-shaped structures bearing marginal protuberances, found capable of continuous growth (Fig. 1). These protuberances revealed the presence of vascular bundles in them connected and traceable to the main structure.

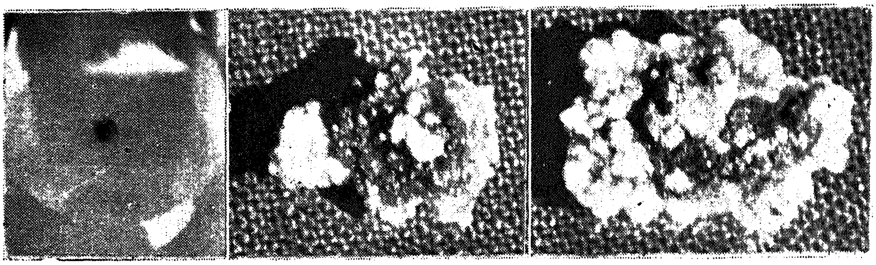


FIG. 1. The development of coloured undifferentiated tissue. A, Stage at inoculum; B and C, different stages in development.

TABLE I

Spot No.	Colour	Colour in U.V.	$R_f \times 100$ values			$\lambda_{max.}$ nm	Banthochromic shift
			BAW	Bu-HCl	1% HCl		
1	Dark orange-red ..	Dull red	46	36	15	505	–
2	Bright magenta ..	Dull magenta	37	26	0·7	525	+
3	Dark purple ..	Dull purple	25	10	0·4	535	+

Accompanying this callous proliferation, in most cases, was the development of dark-red pigment similar to that reported in peach mesocarp tissue,[2] in carrot aggregan tissue culture[3] and in Haplopappus cells.[4] For the purpose of characterization of the pigment, the hard coloured tissue was chopped, extracted with 1% methanolic hydrochloric acid, concentrated and chromatographed on Whatman No. 3 filter-paper, using various developing solvent systems, *viz.*, butanol-acetic acid-water, 4 : 1 : 5 *v/v*, upper phase (BAW), butanol-2 N HCl, 1 : 1 *v/v*, upper phase (Bu-HCl) and 1% HCl. The chromatograms showed three spots which were eluted and subjected to the determination of absorption maxima in 0·01% methanolic hydrochloric acid. The chromatographic and spectral properties given in Table I confirm spot 1 as pelargonidin 3-glucoside, spot 2 as cyanidin 3-glucoside and spot 3 as delphinidin 3-glucoside, the last one in traces only. The acidified extract of uninoculated explants, upon heating develops red colour indicating thereby the presence of leuco-anthocyanin. It is likely that the acidity of the culture medium (pH 6) contributes to the formation of anthocyanins from accumulated precursors.

Grateful acknowledgement is made to Dr. H. K. Jain, Head of the Division of Genetics, for his interest and facilities.

Division of Genetics,
Indian Agric. Res. Inst.,
New Delhi-12,
April 5, 1971.

HAYAT RAM.
C. H. RAO.
J. M. S. MATHUR.

---

1. Nitsch, J. P., *Amer. J. Bot.*, 1951, **38**, 566.
2. Sommer, N. F., Bradley, Muriel, V. and Creasy Min, T., *Science*, 1962, **136**, 264.
3. Sugano, Nobuhiko and Hayashi, Kozo, *Bot. Mag.*, Tokyo, 1967, 80, 440
4. — and —, *Ibid.*, 1967, 80, 481.

GENETICAL STUDIES IN FIVE RADIATION-INDUCED MUTANTS IN JUTE

FIVE radiation-induced mutants[1], *viz.*, *Bushy top, White top, Patchy albino, Round leaf* and *Yellow leaf*, were utilized in diallel crosses and it was thought desirable to study the segregation behaviour of the hybrids originating from these crosses. The study revealed that all the five mutants were recessive in character since they gave normal progeny in F_1 which on self-pollination segregated into 3 : 1 ratio (3 normal :

1 mutant). It might be mentioned here that Das Gupta and Ghose[2] obtained one spontaneously evolved undulated leaf mutant in jute which when crossed with the normal leaved one resulted in an undulated leaf plant but the degree of undulation was not so sharp as that of the undulated parent. This, according to them, indicated partial dominance of the undulated over the flat type. In F_2, however, they observed segregation into 3 : 1 ratio (3 undulated : 1 normal).

Joint segregation of *Bushy top* × *White top*, *Bushy top* × *Patchy albino*, *Bushy top* × *Yellow leaf*, *Bushy top* × *Round leaf*, *White top* × *Patchy albino*, *White top* × *Yellow leaf*, *White top* × *Round leaf*, *Patchy albino* × *Yellow leaf*, *Patchy albino* × *Round leaf* and *Yellow leaf* mutants showed independent assortment into four types, two parental and two recombined ones resulting in a 9 : 3 : 3 : 1 ratio indicating no linkage which was also confirmed by the backcross ratio of 1 : 1 in all the cases except in *Patchy albino* and *Yellow leaf* cross, where no backcrosses could be attempted since the plants died at an early stage of growth.

One exception to this type of segregation was observed when *Patchy albino*, *Yellow leaf* and *Round leaf* mutants used as male parents in *White top* × *Patchy albino*, *White top* × *Yellow leaf* and *White top* × *Round leaf* crosses showed perfectly normal plants in F_1 while their reciprocals gave *White albino* plants like the *White top* parent and perfect green normal plants thereby indicating maternal inheritance. This difference in inheritance was due to the dissimilarity in the cytoplasm of *White top* and *patchy albino*, *Yellow leaf* and the *Round leaf* mutants, which also pointed out that certain combination of factors produced different phenotypic effect. It was further observed that *White-Green normal* plants segregated into a monogenic ratio of 3 : 1 (3 normal : 1 *White top*) which depended upon the derivation of the cytoplasm (Singh and Mitra[3]). *White top* plants showed some perfect green plants along with the *White top* plants indicating its heterozygous nature and the maternal inheritance operating through the cytoplasm of the *White top*. Cytoplasmic inheritance of this type and other kinds have been observed in many plant and animal species[4].

Another interesting phenomenon noticed was that besides *Bushy top* character, this mutant also expressed another variant character, *i.e.*, the presence of *double ovary*, which was controlled by a recessive gene. Furthermore, *double ovary* was found to be closely linked with the *Bushy top* character of the mutant. Although some recombined types were recorded involving these two characters, they were low in frequency.

Sincere thanks are due to Dr. T. Ghosh, Director, Jute Agricultural Research Institute, Barrackpore, West Bangal, for his interest, and to Dr. M. S. Sharma, former Head of the Genetics and Plant Breeding Section of the Institute and Prof. A. Muntzing, former Director of the Institute of Genetics, Lund, Sweden, for suggestions. Thanks are also due to the Indian Council of Agricultural Research for providing the necessary facilities of research.

Jute Agri. Res. Inst., D. P. SINGH.
Barrackpore, West Bengal
and
College of Agriculture, S. BOSE.
University of Calcutta,
Calcutta-19, *June* 24, 1971.

---

1. Singh, D. P., *D. Phil.*, *Thesis in Agriculture*, Univ., Calcutta, 1970, **2**, 1.
2. Das Gupta, B. and Ghose, K. L., *Ind. Jour. Genet.*, **1954**, **15**, 99.
3. Singh, D. P. and Mitra, G. C., *Nucleus*, **1966**, **9**, 225.
4. Serra, J. A., *Modern Genetics*, Acad. Press, Lond., **1968**, **3**, 3.

INDUCED RESISTANCE IN "DULAR" VARIETY OF RICE PLANTS AGAINST *HELMINTHOSPORIUM* INFECTION

INDUCED immunity in plants is one of the most desirable types of defence against diseases. Sinha and Trivedi[1] have shown that a high degree of resistance can be induced in susceptible rice plants against the brown spot fungus, *Helminthosporium oryzae*, by prior inoculation with spore suspensions of an avirulent race, or by pre-inoculation treatment with its heat-killed spore suspension or germination fluid. Results of some further investigations on this problem are briefly reported here.

One susceptible cultivar of rice, *viz.*, "Dular", and two races of *H. oryzae*, one virulent and other mildly virulent, were used. Leaves of 3-week-old plants were initially inoculated by spraying with a conidial suspension of the mild race or sprayed only with water (control). They were reinoculated, 48 hours later, with a standardized inoculum of the virulent race (concentration 5 × 10^5 conidia/ml). Ninety-six hours after the second inoculation, the numbers of brown spots of different size-groups, *viz.*, very small, small, medium and large, were recorded, and from this data disease index was calculated for a plant. There were 30 plants in each treatment, distributed equally in three pots.

Relation between different concentrations of mild inoculum and the immunity induced were studied. Rice plants were initially inoculated with an inoculum of the mild race having 10^5, $2 \cdot 5 \times 10^5$, 5×10^5, 10^6 or 2×10^6 conidia per ml of suspension or sprayed with water. They were reinoculated, 48 hours later, with the virulent race. The induced resistance was reflected not only in the reduced number of spots but also in their reduced size. The mild inocula with 5×10^5 and 10^6 spores per ml appeared to be more effective than the other concentrations and induced respectively 51-66 and 43-46% reductions in symptoms in different experiments. The lower of the two concentrations was used in all further experiments for its optimum immunizing effect.

Whether the resistance induced in rice plants by this method would persist for some time had to be determined. Three-week-old plants were inoculated with the virulent race. Arranged in different groups, these plants had either been inoculated with the mild race 2 to 14 days earlier or sprayed only with water (control). In one experiment, percentage reductions in symptoms in terms of control for gaps of 2, 6, 10 and 14 days between two inoculations were 53·0, 27·5, 8·3 and nil respectively. The symptom inhibitory effect was maximum when the gap was minimum, but it gradually declined as the gap widened. This effect was still appreciable with a gap of 6-8 days, but not if it was longer.

The possibility that rice plants of different ages may have differential sensitivity to immunizing treatments was also tested. For this purpose, seeds were sown at certain intervals, and at a later stage 7-, 10-, 12-, 14-, 21-, 28-, 35- and 42-day-old plants were inoculated with the mild and virulent races at an interval of 48 hours. Each group had its own inoculated controls. Reduction in symptoms was rather small in week-old plants, but this effect of first inoculation increased with age to a maximum of about 65% in 3-week-old plants. The effect declined, however, with further increase in age, 6-week-old plants recording about 45% reduction.

In the present investigation also, cell-free germination fluid, prepared from spore suspensions of the mild race after 24 hours' incubation at 27° C, effectively induced resistance in rice plants when sprayed on to the leaves as a replacement of the live inoculum. At the lowest concentration used (*c.* 5×10^5 conidia/ml), the germination fluid was about half as effective in reducing symptoms as the live spore suspension. As the concentration increased, the fluid showed progressively superior symptom inhibitory effects, so much so that at the highest concentration employed (*c.* 2×10^6 conidia/ml), its effect was higher by about 60% than that of the live inoculum.

While it is true that considerable resistance can be induced in rice plants against *H. oryzae* by prior inoculation with a mildly virulent or avirulent race, this effect does not appear to persist for long. In this background, any attempt to find out a better immunizing treatment in the sense that it will induce a more permanent type of resistance in rice plants may be rewarding.

Dept. of Plant Pathology,
University of Kalyani,
Kalyani, West Bengal,
May 4, 1971.

N. DAS.
A. K. SINHA.

---

1. Sinha, A. K. and Trivedi, N., *Nature*, 1969, **223**, 963.

REVIEWS AND NOTICES OF BOOKS

Advances in Experimental Medicine and Biology—The Human Testis, Vol. 10. Edited by E. Rosemberg and C. A. Paulsen. (Plenum Publishing Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xxiv + 645. Price $ 19.50.

The testis is an extrordinary organ. Like its female counterpart, the ovary, it performs the dual function of producing germ cells and the specific hormones required for the proper functioning of the rest of the reproductive system and for sexual behaviour. Yet, the metabolically active organ lives, as it were, on the brink of disaster. It is so sensitive to temperature that it has to be suspended in the scrotum to lower its temperature by 2-3°.

The development of laboratory research and biochemical techniques has led to progress in important areas of testicular biology. Histophysiological evidence for some basic mechanisms operating in the male gonad has been adduced. This is with special reference to the cellular and subcellular morphology of germinal epithelium and interstitial Leydig cells and to the final products of both structures, sperm cells and male hormones and to the feed back phenomena with the hypophysis.

The aspects of studies on 'Testes' currently under active investigations pertain to the dynamics of the human spermatogenic process which is replacing the old wave cycle concept of classical cytologists; and the sustentacular and nutritional function of Sertoli cells related to germinal cells and spermatozoa; the functional significance of the physico-chemical composition of seminiferous tubular structures; the development and fate of sex chromosomes in the germinal cells; histochemical aspects of spermatogenesis; the effect of pituitary gonodotropic hormones on the development of germinal and Sertoli cells and interstitial cells.

This volume, *The Human Testis,* which reports the proceedings of a Workshop Conference held at Positamo, Italy, during April 23-25, 1970, by presenting recent investigations on the above topics has added a new dimension to our knowledge by outlining new evidence and provoking additional thoughts for further studies. Subjects dealt with also include the studies of the immunological factors and chromosomal anomalies of germinal cells to elucidate the disturbances in the mechanism of spermatogenesis; the significance of seminal plasma chemical composition as an indicator of the adnexal gland function and assessment of gonadotropin therapy in the still debatable field of male sterility.

This volume is recommended to embryologists, biologists, biochemists, pathologists, geneticists and endocrinologists interested in the field of physiology and pathology of the human testes.

M. Sirsi.

Vacuum Microbalance Techniques

(1) Vol. 7, Edited by C. H. Massen and H. J. Van Beckum. *Proceedings of the Eindhoven Conference* (June 1968). (Plenum Press, New York, London), 1970. Pp. xv + 238. Price $ 22.50.

(2) Vol. 8, Edited by A. W. Czanderna. *Proceedings of the Wakefield Conference* (June 1969). (Plenum Press, New York, London), 1971. Pp. xiii + 251. Price $ 22.50.

Microbalance Techniques find increasing new applications every year. It is gratifying to observe that the outstanding results contributed to this interesting field are consolidated and presented succinctly at the Annual Conferences organised at different centres ever since 1960. The proceedings of such conferences of scientists and engineers form the subject-matter of a series of publications. The volumes under review, 7 and 8, contain 21 and 18 original papers respectively. The application of this admirable technique for the following intricate problems are described with the best illustrations by the most distinguished authors:

(*a*) Determination of diffusion coefficients of vapours.
(*b*) Measurements of magnetic susceptibility and related parameters.
(*c*) Oxidation and reduction studies.
(*d*) Thermogravimetry.
(*e*) Improvements in the instrumentation techniques such as ultra high vacuum microbalance, crystal oscillator microbalance, etc.
(*f*) Mass defect produced by thermal gradient.
(*g*) Adsorption studies under a variety of experimental conditions.

(*h*) Simultaneous use of mass spectrometer and microbalance techniques.

It is no exaggeration to find that a total of 125 papers spread over these 8 volumes serve as a major repository of the world literature on vacuum microbalance techniques. The entire series will be an asset to any institution engaged in research and developmental work.

A. R. VASUDEVA MURTHY.

Progress in Stereochemistry, Vol. 4. By Aylett and Harris. (Plenum Press, New York and Butterworths, London), 1969. Pp. vii + 389. Price $ 30.00.

The book under review is the latest issue of the well-known series started by Klyne and de La Mare. It consists of eight chapters. The topics covered include Stereochemistry of Myoglobin (H. G. Watson), Stereochemical correlations (W. Klyne and P. M. Scopes), Crystallography and Stereochemistry (H. H. Mills and J. C. Speakman), N.M.R. Spectroscopy and Inorganic Chemistry (R. F. M. White), Configuration Analysis in Carbohydrate Chemistry (R. J. Ferrier), Stereochemistry of 2, 2′-Bridged Biphenyls (D. Muriel Hall), Stereochemistry of Main Group IV Elements (B. J. Aylett) and the Use of Models in Stereochemistry (A. Walton).

The topics have been chosen with care to present a fair view of the advancing fronts of Stereochemistry. The materials have been handled in an expert fashion. It is clear that the renaissance in Stereochemistry of the 50's although originated in Classical Organic Chemistry is influencing profoundly not only Physical Organic Chemistry but Inorganic and Biological Chemistry, Molecular Biology, Pharmacologiy and Polymer Chemistry as well. The book is indispensable for all departmental libraries of chemical, biological and physical sciences.

M. V. BHATT.

Biophysik des Muskels. By E. Ernst. (Fortschritte der experimentellen und theoretischen Biophysik—Heft 12) (Published by Veb Georg Thieme, Leipzig, DDR-69 Jena, Villengang 2), 1970. Pp. 71. 38 illustrations. Price 18 Mark.

This monograph on Biophysics of Muscles by Prof. Dr. E. Ernst, Director of the Bio-Physical Institute, Pécs (VR Ungarn) is Part 12 of the series Progress in Experimental and Theoretical Biophysics. It gives brief accounts of recent major developments in the subject, and reviews the work that has been published during the past decade. The contents in two major chapters deal (*i*) with muscles, their structure incluling micro- and sub-micro as revealed by electronmicroscope studies, the muscle fibres, their contents and localisation and (*ii*) with the mechanism of muscle actions, their energetics, automatism, the contraction theories, sliding hypothesis, etc. The literature quoted contains 323 references to original papers, mostly published during the decade ending 1968.

Research workers in this field will find a valuable reference source in this monograph.

A. S. G.

ANNOUNCEMENTS

Nuclear Physics and Solid State Physics Symposium, 1971

Venue: Bhabha Atomic Research Centre, Trombay, Bombay.

Date: December 27–31, 1971.

Deadline for Abstracts: November 1, 1971.

Deadline for Papers: November 20, 1971.

Please contact: Dr. N. S. Satya Murthy (Convener) for general information; Dr. D. K. Sood for Nuclear Physics Abstracts; Dr. B. A. Dasannacharya for Solid-State Physics Abstracts; Dr. K. R. Rao for local arrangements; Nuclear Physics Division, Bhabha Atomic Research Centre, Trombay, Bombay-85.

Books Received

Semiconducting Lead Chalcogenides. By Yu. I. Ravich, B. A. Efimova, I. A. Smirnov. (Plenum Publishing Corporation, New York), 1970. Pp. xv + 377. Price $ 30.00.

Topics in Mathematical Physics—Vol. 2—*Special Theory and Problems in Diffraction.* Edited by M. Sh. Birman. (Plenum Publishing Corporation, New York), 1968. Pp. vii + 134, Price $ 15.00.

System Theory Research (Vol. 19). Edited by A. A. Lyapunov. (Plenum Pub. Corpn., New York, N.Y.), 1970. Pp. vi + 321. Price $ 27.50:

Theory of Moleoular Excitons. By A. S. Davydov. (Plenum Pub. Corpn., New York), 1971, Pp. xiii + 313. Price $ 25.00.

3013-71. **Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, L.P.T., Superintendent, at The Bangalore Press, Bangalore-18.**

CHEMICAL STUDIES OF *PSORALEA CORYLIFOLIA*

PYARE LAL KHANNA AND T. R. SESHADRI
Department of Chemistry, University of Delhi, Delhi-7

INTRODUCTION

PSORALEA CORYLIFOLIA (Hindi-Bavachi) is a well-known plant drug. As a legume it grows widely all over India and requires little attention. Its full utilisation has not yet been accomplished. The chemical studies on this plant started nearly 40 years ago and periodically new discoveries have been reported and yet it would appear that there is possibility of discovering more.

The seed (more correctly the fruit) is brownish-black in colour, has soft skin, pleasant odour (Sanskrit name Sugandha) and a pungent bitter taste and has been used widely in medicine. It has been reported to have antiseptic properties either in its fresh form or in the form of watery extracts prepared from it. In inflammatory diseases of the skin, leucoderma and psoriasis, it is given both as a local application and by the mouth. The seeds are frequently used in several toilet preparations because of their prophylactic and curative action against skin diseases.

CHEMICAL COMPONENTS OF *P. corylifolia*

The chemistry of the seeds has been a subject of investigation of a number of workers. Menon[1] obtained the fatty oil from the seeds and determined its physical and chemical constants. Jois *et al.*[2], besides examining in greater detail the fixed oil of the seeds, were able to isolate two crystalline compounds, psoralen and isopsoralen. The latter was identified[3] to be angelicin and psoralen was studied, its constitution established and synthesis effected[4]. In their method the whole seeds (fruits) were crushed or powdered and extracted and hence pure fractions could not be obtained easily. A method was developed by Seshadri *et al.*[5], which enabled the separation of the components more efficiently in greater purity and yield and at the same time giving information regarding the parts of the seeds in which they occur. The seed or fruit consists of a sticky oily pericarp, a hard seedcoat and a kernel. The whole seed cannot be easily powdered owing to the sticky pericarp. However, the pericarp can be removed by soaking the whole seed in ether, methylated spirit or light petroleum and gentle rubbing; this leaves the seedcoat and kernel intact. The above ether extract contains a steam volatile essential oil, an alkali soluble resin and a terpenoid liquid insoluble in alkali. Thus these are present only in the pericarp and not in the kernel.

When the ether extracted material was rubbed, the remaining pericarp could be easily removed and the seed can be conveniently powdered. This on extraction with light petroleum in a Soxhlet gave a colourless crystalline solid (1·1% of the fresh seed) found to be a mixture of psoralen and isopsoralen and also a fixed oil consisting almost completely of glycerides. The unsaponifiable portion of the fixed oil was found to contain a phytosterol. Besides these components, the kernel, also contains nitrogenous and mineral matter which make it suitable as a feeding stuff and manure. The importance of this work lies in the ease with which each component of the drug is obtained practically uncontaminated by others and in highly increased yields.

That the sterol of the seed fat of *P. corylifolia* was stigmasterol was proved by Khastgir *et al.*[6]. It was also shown by Khastgir *et al.*[7] that some psoralen and isopsoralen could be obtained from the water soluble glycosidic fraction of the seed kernel after hydrolysis with alcoholic hydrochloric acid. In this connection it may be mentioned that psoralen had earlier been found[8] to occur as the glycoside of the corresponding *o*-hydroxycinnamic acid (I *a*) in the seeds of *Coronilla glauca*, a species well known for cardiac glycosides.

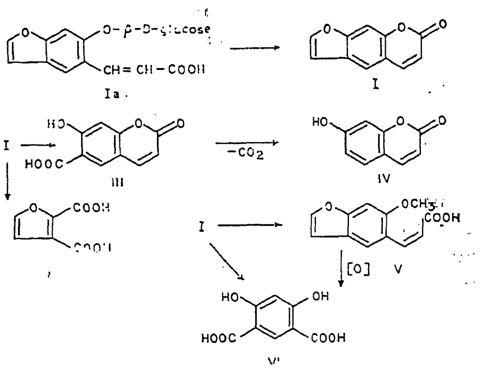
STUDY OF FURANOCOUMARINS AND PSORALIDIN

In general furanocoumarins produce photosensitivity and hence the presence of these coumarins in *P. corylifolia* is responsible for photodynamic activity. The active principles psoralen and isopsoralen have been identified to be isomeric furanocoumarins. In addition to these, psoralidin has been isolated from the pericarp of the seeds.

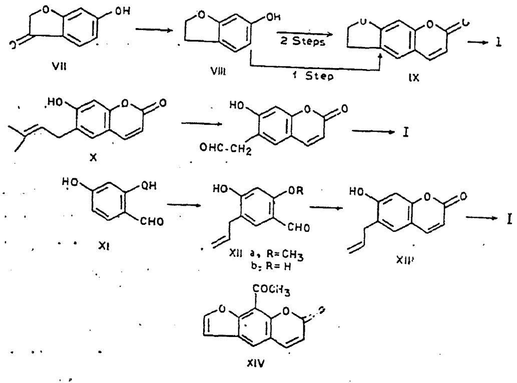
Psoralen.—It is the simplest linear furanocoumarin having high photodynamic activity and is an effective drug for the cure of leucoderma. It has been isolated from a number of other sources also. As mentioned above

β-D-glucosidofuranocoumaric acid (I *a*) occurring in Nature is readily split by emulsin or acid yielding psoralen after spontaneous lactonization.

The constitution of psoralen (I) was established by Spath *et al.*[4,9]. It showed the properties of a lactone and on oxidation with alkaline hydrogen peroxide it gave furan-2, 3-dicarboxylic acid (II). On the other hand with potassium permanganate, it formed a hydroxycarboxylic acid (III) which on decarboxylation yielded umbelliferone (IV), thus establishing the furanocoumarin nature of psoralen. The linear fusion of the furan and coumarin rings was indicated by methylation of psoralen in alkaline medium to a methoxycinnamic acid (V) which on oxidation gave a dicarboxylic acid (VI), identified to be 2, 4-dimethoxy-1, 5-dicarbomethoxy benzene after methylation. Further psoralen on fusion with KOH yielded directly 2, 4-dihydroxy-1, 5-dicarboxylic acid (VI).



The structure of psoralen was confirmed by its synthesis by Späth *et al.*[4,9] starting from 6-hydroxycoumaranone (VII) prepared from resorcinol and chloroacetyl chloride. This was reduced with H_2 and Pd-charcoal to give 6-hydroxycoumaran (VIII). Condensation with malic acid and conc. H_2SO_4 gave dihydropsoralen (IX) which on dehydrogenation yielded psoralen (I). Alternatively 6-hydroxycoumaran (VIII) when subjected to Gattermann reaction followed by Perkin condensation afforded dihydropsoralen (IX) which could be converted to psoralen by dehydrogenation. This synthesis involves a number of steps and the yields are very poor.

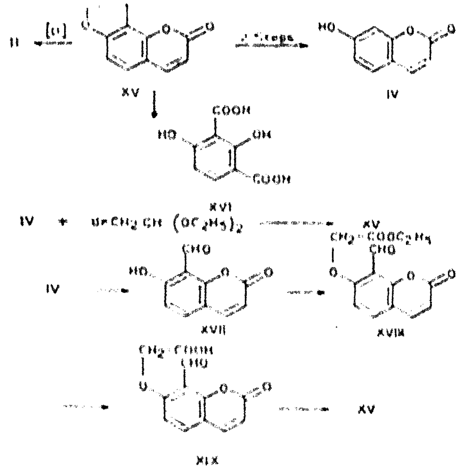


The above synthesis was improved and modified by others[10,11]. Later on Aneja *et al.*[12] synthesised psoralen following a possible path of biogenesis of a furan ring in natural products based on *o*-hydroxy dimethylallyl group. They were able to convert demethyl suberosin (X) occurring in Nature by ozonolysis and subsequent ring closure to psoralen (I).

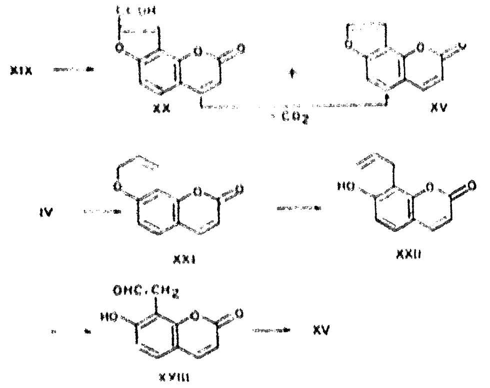
Seshadri and Sood[13] modified the above synthesis using a simple allyl group in place of γ, γ-dimethylallyl group. The essential intermediate in this synthesis is 6-allyl-7-hydroxycoumarin (XIII). It could not be prepared by Claisen migration of 7-allyloxy coumarin because the reaction gives the isomeric 8-allyl-7-hydroxycoumarin. Hence the allyl group was introduced at an earlier stage. β-Resorcylaldehyde (XI) on *O*-allylation, methylation and Claisen migration gave 2-methoxy-4-hydroxy-5-allyl benzaldehyde (XII *a*); demethylation gave the hydroxy compound (XII *b*) which by Perkin condensation yielded 6-allyl-7-hydroxycoumarin (XIII). This on ozonolysis and subsequest ring closure led to psoralen (I). It is the most convenient synthesis giving good yields of psoralen.

Following a similar biogenetic route, a number of other related compounds including 8-acetyl psoralen (XIV) were prepared[13]. It was observed that the introduction of an acetyl group reduces the activity of psoralen but still these compounds may be useful as they are easily made and can be used where milder action is needed.

Isopsoralen.—It is the angular isomer of psoralen and it was found to be identical with angelicin isolated earlier from the roots of *Angelica archangelica*. It is also present along with psoralen in *Angelica kiskei*. Its structure was established by Späth and Pesta[14] in 1934 based on various degradative reactions. Alkaline hydrogen peroxide oxidation gave furan-2, 3-dicarboxylic acid (II) while regulated oxidation with $KMnO_4$ yielded umbelliferone-8-carboxylic acid in poor yields which on decarboxylation gave umbelliferone (IV). By methylation with alkaline dimethyl sulphate, isopsoralen yielded a methoxycinnamic acid ester and its oxidation with $KMnO_4$ gave 2, 4-dihydroxyisophthallic acid (XVI), thus indicating the angular fusion of the furanocoumarin ring system. All these reactions are explained in the following formulae.



The structure of isopsoralen (XV) has been confirmed by a number of synthesis carried out by Späth *et al.*[15]. In one case the dry sodium salt of umbelliferone was heated with bromoacetaldehyde diethyl acetal to give a small amount of isopsoralen (XV).



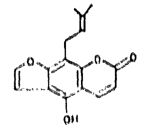
In another method umbelliferone was formylated by Duff's reaction to give 8-formyl-7-hydroxycoumarin (XVII) which on treatment with ethyl iodoacetate yielded 8-formyl-7-O-carbethoxy-methyl umbelliferone (XVIII). Further steps are saponification to the free glycollic acid (XIX) and boiling with sodium acetate-acetic anhydride to yield isopsoralen (XV).

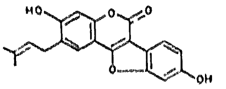
Later Naik *et al.*[16] repeating this step observed that the acid (XIX) gave 2′-carboxy-isopsoralen (XX) along with some isopsoralen (XV) and separate decarboxylation of the former improved the yield of isopsoralen.

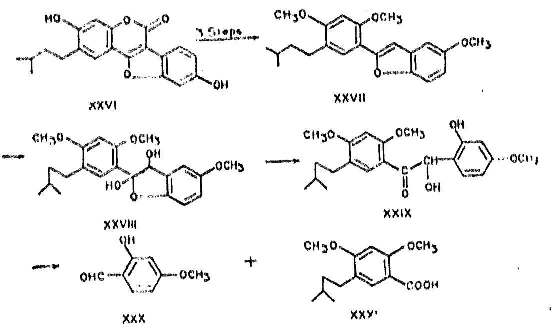
However, the most convenient synthesis of isopsoralen was that of Aneja *et al.*[12] in which 8-allyl umbelliferone (XXII) is converted into the acetaldehyde derivative (XXIII) by ozone. The aldehyde when treated with polyphosphoric acid cyclised to isopsoralen. A convenient modification for small quantities is to use KIO_4-OsO_4 as was done by Raizada *et al.*[17]. 8-Allyl umbelliferone (XXII) needed for this synthesis was prepared from 7-O-allyl umbelliferone (XXI) by Claisen migration.

As a result of detailed investigations, linear furanocoumarins have been found to have high photodynamic activity and angular ones much less; isopsoralen is only ¼ as active photodynamically as its linear isomer psoralen which is the most powerful compound so far known.

Psoralidin.—It was first isolated by Chakravarti *et al.*[18] from the pericarp of the fruit and given the molecular formula $C_{16}H_{14}O_4$. The presence in the molecule of a phenolic hydroxyl group, a lactone ring and an isopentenyl group was detected by them and they suggested the furanocoumarin structure (XXIV).

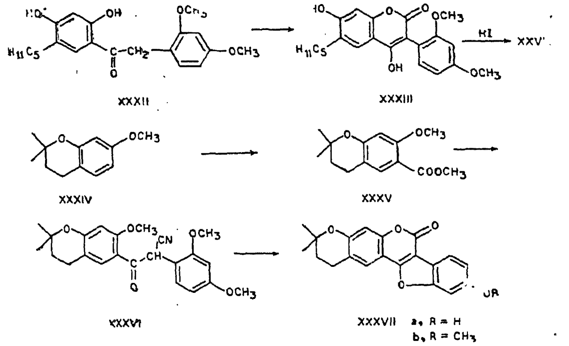

XXIV


XXV



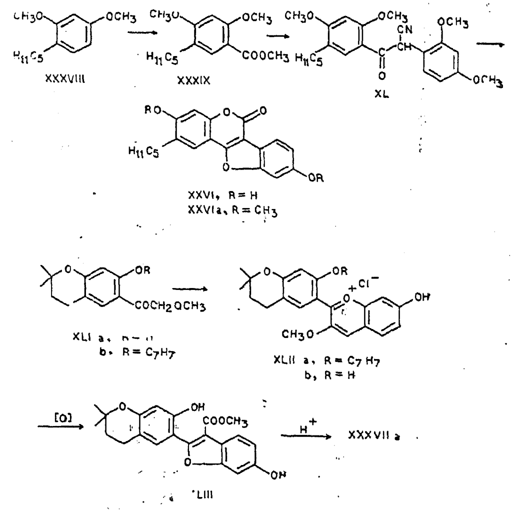
Dattagupta and co-workers[19,20] later showed that it possesses one unsaturated δ-lactone, an isopentanyl side-chain and an intramolecular ether linkage. Based on detailed chemical study supported by UV and IR data, they proposed that it had the structure of 6-isopentenyl coumestrol (XXV). Its reactions are explained below. In the presence of acid it isomerises into the related 2, 2-dimethylchroman. After saturation of the isopentenyl side-chain, the dihydro compound (XXVI) is stable to acids. But on hydrolysis with alkali and methylation followed by decarboxylation it gave the benzofuran (XXVII). The later steps involve treatment with osmium tetraoxide to give hydroxylated product (XXVIII) isomerising to the ketonic alcohol (XXIX), which is cleaved with periodic acid giving 2-hydroxy-4-methoxybenzaldehyde (XXX) and the isopentyl benzoic acid (XXXI).

The above structure of psoralidin (XXV) has been confirmed by the synthesis of its dihydroderivative by Nasipuri and Pyne[21,22]. The isopentyldesoxybenzoin (XXXII), prepared by Hoesch condensation of isopentyl resorcinol and 2, 4-dimethoxybenzyl cyanide, was condensed with ethyl chloroformate and potassium carbonate. The product was 4, 7-dihydroxy-6-isopentyl-3-(2, 4-dimethoxyphenyl) coumarin (XXXIII). This on demethylation with HI underwent ring closure also to give dihydropsoralidin (XXVI).



Isopsoralidin (XXXVII *a*) was synthesised later by Chatterjea *et al.*[23]. The synthesis started from 7-methoxy-2, 2-dimethylchroman (XXXIV) and involved the following steps. Formylation, oxidation and esterification gave 6-carbomethoxy-7-methoxy-2, 2-dimethyl chroman (XXXV). Condensation with 2, 4-dimethoxybenzyl cyanide in the presence of sodium hydride gave the α-cyanodesoxybenzoin (XXXVI). Further treatment with pyridine hydrochloride gave isopsoralidin (XXXVII *a*) which was isolated as its methyl ether (XXXVII *b*).

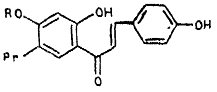
Similar steps were used by the same authors for the synthesis of dihydropsoralidin (XXVI) starting from 4-isopentyl-1, 3-dimethoxybenzene (XXXVIII). The resulting product, after treatment with pyridine hydrochloride, gave dihydropsoralidin which was isolated as its dimethyl ether (XXVI *a*).



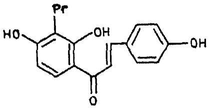
Very recently isopsoralidin has also been synthesised by Molyneux and Jurd[24] employing a novel route. The essential method is the oxidation of a flavylium salt to give a benzofuran derivative. A Hoesch reaction between 7-hydroxy-2, 2-dimethylchroman and methoxyacetonitrile gave ω-methoxyacetophenone (XLI *a*), the phenolic hydroxyl group of which was protected by the formation of the benzyl ether (XLI *b*). Its condensation with 2, 4-dihydroxybenzaldehyde in ether solution saturated with gaseous HCl gave the flavylium salt (XLII *a*) which was readily debenzylated by a mixture of glacial acetic acid and conc. hydrochloric acid to yield the phenolic flavylium salt (XLII *b*). Oxidation of the flavylium salt with 30% aqueous hydrogen peroxide resulted in ring contraction to the furan (XLIII) which on acidification readily lactonized to isopsoralidin (XXXVII *a*).

CHALCONES AND FLAVANONES

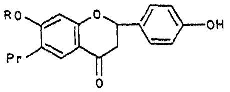
A recent closer examination by Bhalla *et al.*[25] of the chloroform extract of the petroleum ether exhausted whole seeds of *P. corylifolia* has revealed the presence of three *C*-prenylated flavanones along with two corresponding chalcones. These are likely to be the components of the resin part of pericarp. The names assigned to them by the discoverers were not free from ambiguity. In order to make them more rational Seshadri and co-workers[26] considered the chalcones as the primary products which underwent change into flavanones. Bavachalcone (XLIV *a*) would then be the primary member of this group but it has not been so far isolated from this plant. But its related flavanone bavachin (XLVI *a*) is present, which is an indication that the chalcone is also likely to be present. Its 4′-*O*-methyl derivative (XLIV *b*, *O*-methylbavachalcone) is however found to occur in this plant. The corresponding flavanone 7-*O*-methylbavachin (XLVI *b*) has also the synonym bavachinin. Isobavachalcone (XLV) and isobavachin (XLVII) have rational names since they are isomers of bavachalcone and bavachin.



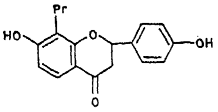
XLIV a, R = H
b, R = CH₃



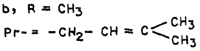
XLV

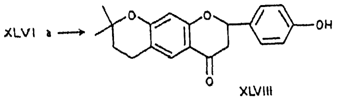


XLVI a, R = H
b, R = CH₃

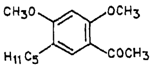


XLVII

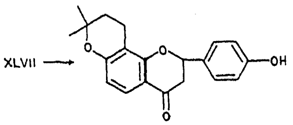

$Pr- = -CH_2-CH=C<^{CH_3}_{CH_3}$ unit



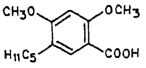
XLVIII



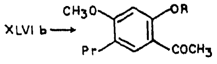
LII



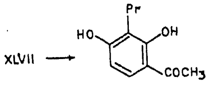
XLIX



LIII



L a, R = H
b, R = CH₃

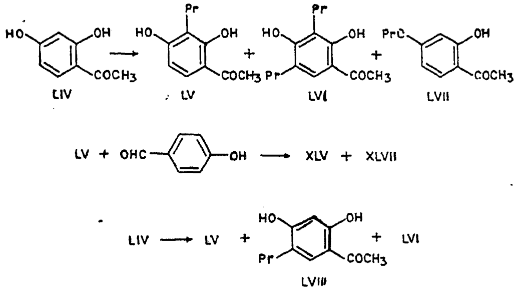


LI

The structures of these closely related flavonoids were established on the basis of spectroscopic evidence. A study of the UV spectra indicated the coloured compounds *O*-methylbavachalcone (XLIV *b*) and isobavachalcone (XLV) to have chalcone structures. The position of the hydroxyl group in the side phenyl was established by a study of bathochromic shifts in UV with alkali and also by the characteristic A_2B_2 pattern in the NMR. The C_5 unit was also located in the nucleus by NMR spectra. Thus in the compounds *O*-methyl bavachalcone (XLIV *b*), bavachin (XLVI *a*) and *O*-methylbavachin (XLVI *b*) there were only two para coupled aromatic protons of ring A, one of them being deshielded by the carbonyl group. The vicinal nature of the hydroxyl and C_5 unit was established by acid treatment of the compounds bavachin (XLVI *a*) and isobavachin (XLVII) when the corresponding chromans (XLVIII) and (XLIX) were obtained.

These findings were supported by the conversion of the chalcones into the corresponding prenylated acetophenones. Thus the compounds 7-*O*-methylbavachin (XLVI *b*) and isobavachin (XLVII) on degradation with alkali gave the corresponding ketones (L *a*) and (LI) besides *p*-hydroxybezoic acid. The structures of the ketones were supported by spectral evidence and further that of former was confirmed by catalytic hydrogenation of its methyl ether (L *b*), when the product obtained was found to be identical with (LII) prepared synthetically from 5-isopentyl-2, 4-dimethoxybenzoic acid (LIII) by treatment with methyl lithium.

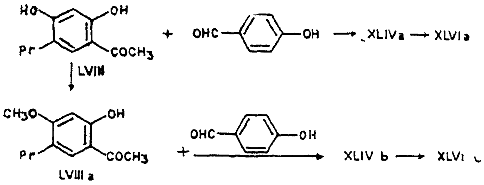
An unambiguous synthesis of these compounds has been recently carried out by Jain *et al.* [26,27]. It has been done following a possible biogenetic route, which involves C-prenylation either at the ketone stage or at the chalcone stage. Both the approaches were successful. In this work nuclear prenylation of β-resacetophenone was carried out under alkaline[27] as well as acidic conditions[26]. β-resacetophenone (LIV) on nuclear prenylation with prenyl bromide and alkali gave a mixture of 3-*C*-prenyl (LV), 3, 5-di-*C*-prenyl (LVI) and 4-*O*-prenyl derivatives (LVII) among which 3-*C*-prenyl compound was in maximum amount.

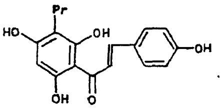


Condensation of the 3-*C*-prenyl resacetophenone (LV) with *p*-hydroxybenzaldehyde in the presence of conc. alcoholic alkali[27] gave a mixture of isobavachalcone (XLV) and isobavachin (XLVII), identical in properties with the natural compounds. The former was also converted to the latter by treatment with dilute alkali.

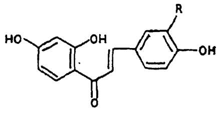
In the above prenylation experiment no 5-*C*-prenyl derivative was obtained. In order to obtain this isomer also, the nuclear prenylation of β-resacetophenone was studied under acidic conditions using 2-methyl-but-3en-2-ol in the presence of boron trifluoride etherate. Here a mixture of 5-*C*-prenyl (LVIII), 3, 5-di-*C*-prenyl (LVI) and 3-*C*-prenyl derivatives (LV) was obtained, the first being in maximum amount.

5-*C*-Prenyl resacetophenone (LVIII) and its 4-*O*-methyl derivative (LVIII *a*) were condensed with *p*-hydroxybenzaldehyde separately to give bavachalcone (XLIV *a*) and 4′-*O*-methyl bavachalcone (XLIV *b*) respectively and these on isomerisation with dilute alkali gave corresponding flavanones, bavachin (XLVI *a*) and 7-*O*-methyl bavachin (XLVI b) respectively.

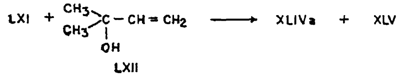




LIX



LX, R = OH
LXI, R = H



BIOGENETIC CONSIDERATION AND INTERRELATIONSHIP

The fruit (seed) of *P. corylifolia* contains a large number of components. They belong to different groups, furano-coumarins, coumestrol group (isoflavonoid), chalcones and flavanones. They contain the following structural units, C_9, C_6 and C_5. The simple coumarins are derived from C_9 units and the furan rings in psoralen and isopsoralen have been considered to arise[13] from C_5 (isoprene) units. This C_5 unit is also present in psoralidin as a open chain substituent. The main structure in psoralidin is that of coumestrol whose skeleton is isoflavonoid in Nature. In an earlier publication[28] the evolution of coumestrol type of compounds from related isoflavanones was discussed and hence it is justified to include these compounds under isoflavonoids. Chalcones and flavanones mentioned above also carry terpenoid C_5 units and details of their biogenesis are discussed below.

Bhalla *et al.*[25] suggested that an intermediate (LIX) with phloroglucinol A-ring is first formed which undergoes ring closure in different ways and subsequent dehydroxylation in order to produce bavachin and isobavachin. Since resorcinol derivatives are very common among chalcones, *e.g.*, butein (LX) and isoliquiritigenin (LXI), Seshadri and co-workers[26] considered isoliquiritigenin (LXI), as the primary member of this series. Analogous to *β*-resacetophenone, it should undergo prenylation at both 5′- and 3′-positions yielding bavachalcone and isobavachalcone, which by ring closure would yield bavachin and isobavachin. The partial methylation of the 4′-position of the chalcones of this type and 7-position of the flavanones is an easy reaction both in Nature and in the laboratory and accounts for the presence of 4′-*O*-methyl bavachalcone and 7-*O*-methyl bavachin.

In support of the above scheme for the evolution of prenylated chalcones, isoliquiritigenin (LXI) was condensed[26] with 2-methyl-but-3-en-2-ol (LXII) in the presence of a Lewis acid. The resulting product, a mixture of two compounds, was separated into 5′ *C*-prenyl isoliquiritigenin (or bavachalcone, XLIV *a*) and 3′-C-prenyl isoliquiritigenin (or isobavachalcone XLV).

---

1. Menon. *Agricultural Ledger*, 1911–12, **17**, 139.
2. Jois, H. S., Manjunath B. L. and Venkatarao, *J. Ind. Chem Soc.*, 1933, p. **41**.
3. — and —, *Ber.*, 1936, **69**, 964
4. Späth, E., Manjunath, B. L., Jois H. S. and Pailer, M., *Ibid.*, 1936, **69**, 1087.
5. Seshadri, T. R. and Venkatarao, C, *Proc. Ind. Acad. Sci.* 1937, **5 A** 351.
6. Khastgir, H. N., Datta Gupta, P. C and Sengupta, P., *Ind. J. App. Chem*, 1959, **22**, 35.
7. —, — and —, *Ibid.*, 1959. **22,** 82.
8. Stoll, A., Pereira, A. and Renz, J., *Helv. Chim. Acta*, 1950, **33**, 1637.
9. Späth, E, Okahara, K. and Kuffner, F., *Ber.*, 1937, **70**, 73.
10. Foster, R. T., Robinson, A. and Bushra, A., *J. Chem. Soc.*, 1948. p. 2254.
11. Horning, E C. and Reisner, D. B., *J. Am. Chem. Soc.*, 1948, **70**, 3619.
12. Aneja, R., Mukerjee, S. K. and Seshadri, T. R., *Tetrahedron*, 1958, **4**, 256; 1958, **2**, 203.
13. Seshadri, T. R. and Sood, M. S., *Int. J. Chem.*, 1963, **1**, 291.
14. Späth, E. and Pesta, O., *Ber.*, 1934, **67**, 853.
15. — and Pailer, M, *Ibid.*, 1934, **67**, 1212; 1935, **68 B**, 941.
16. Naik R M. and Thakor, V. M., *J. Org. Chem.*, 1957, **22**, 1096.
17. Raizada, K. S., Sarin, P. S. and Seshadri, T. R., *J. Sci. Ind. Res.*, 1960, **19 B**, 76.

18. Chakravarti, K K., Bose A. K. and Siddiqui, S., *J. Sci. Ind. Res.*, 1948, **7 B**, 24.

19. Dattagupta, P. C., Khastgir, H. N. and Sengupta, P., *Chem and Ind.*, 1960, p. 48.

20. —, — and —, *Tetrahedron*, 1961, **14**, 275.

21. Nasipuri, D. and Pyne, G., *J. Sci. Ind. Res.*, 1962, **21 B**, 51.

22. — and —, *J. Chem. Soc.*, 1962, p. 3105.

23. Chatterjea, J. N., Banerji, K. D. and Prasad, N., *Ber.*, 1963, **96**, 2356.

24. Molyneux, R. J. and Jurd, L., *Tetrahedron*, 1970, **26**, 4743.

25. Bhalla, V. K., Naik, U. R. and Sukhdev, *Tetrahedron Letters* 1968, **20**, 2401.

26. Jain, A. C., Pyare Lal and Seshadri, T. R., *Tetrahearon*, 1970, **26**, 2631.

27. — — and —, *Ind. J. Chem* , 1969, **7**, 1072.

28. Krishnamurti, M. and Sesnadri, T. R., *Curr Sci.*, 1966, **35**, 167.

STUDIES ON OPTICAL BLEACHING OF X-RAY IRRADIATED NaCl CRYSTALS

K. VIJAYALAKSHMI AND K. N. KUCHELA

Physics Department, Central College, Bangalore University, Bangalore

ABSTRACT

The regions of fast first stage bleaching and the slow second stage bleaching of F-centres in 'as cleaved' X-ray irradiated NaCl crystals at room temperature are not clearly separated out in the optical bleaching curves. These curves are explained by a simple relation of the form $\Delta\alpha_p/\alpha_{0p} = k \log t$, $\Delta\alpha_p$ being the change in absorption coefficient at the F-band peak after bleaching the colored crystal for t minutes, α_{0p} being the absorption coefficient at the F-band peak before bleaching and k being the constant dependent on the time of X-ray irradiation. The two regions are distinctly separated out in the case of heat-treated NaCl crystals. A possible mechanism of bleaching is suggested to explain the results of optical bleaching.

INTRODUCTION

IT is well established by several authors[1-8] that F-centres are formed in alkali halides by X-rays by two distinct processes. In one of them the negative ion vacancies initially present in the crystal, trap electrons liberated by X-rays and these are uniformly distributed in the volume of the crystal. In the other process, new vacancies are generated during irradiation and these in turn may trap electrons and form additional F-centres. These F-centres are formed perhaps near some defects and are highly localized in small regions of the crystal having very high concentration of these F-centres.

The optical bleaching of F-centres also supports the idea of two stages of coloration. The studies on optical bleaching of F-centres by Markham *et al.*[9] on additively colored KBr crystals at low temperatures, by Ueta and Werner Kanzio[10] on additively colored, deformed KCl crystals, and by Bron[5] on the relation between X-ray coloration and optical bleaching indicate that optical bleaching of F-centres also takes place in two stages. During the first stage of bleaching the F-band decreases rapidly and this can be attributed to the bleaching of first type F-centres. During the second stage of bleaching, the decrease in F-band is much slower and this can be attributed to the bleaching of second type F-centres.

In the present paper optical bleaching curves of F-centres have been studied systematically to investigate the nature of these two stages of bleaching at room temperature in X-irradiated Harshaw NaCl crystal (as cleaved and heat-treated crystals).

EXPERIMENTAL

Sodium chloride crystals used in the present study were aged about 8 to 10 years. Systematic experiments were conducted to find the origin of these crystals. Rabin and C. C. Klick[11] have studied the F-band growth curves for NaCl crystals of different origins. The F-band growth curve obtained from our experiments agreed well with that obtained by Rabin and Klick for Harshaw NaCl crystals.

NaCl crystals were cut and cleaved to the size required from a big block. The thickness of the crystals used was less than 0·4 mm.

Heat treatment of NaCl crystals consisted in raising their temperature to about 600° C and maintaining them at that temperature for 7 to 8 hours, then quenching immediately by withdrawing them from the furnace and cooling on a copper plate.

The continuous X-ray spectrum from a copper target tube operated at 39 kV and 10 mA was employed to produce the coloring. The cleaved crystals, wrapped in black paper were placed close to the window of the X-ray tube. The irradiation time varied from 10 minutes to 12 hours.

Progressive optical bleaching of previously X-irradiated crystals was carried out by placing the crystals within about 8 cm from a 250 V 60 W incandescent bulb with an electric fan nearby to keep the crystal cool.

Optical absorption measurements were made using DU-2 Beckmann non-recording type Spectrophotometer in the wavelength range from 400 mμ to 900 mμ. The optical density $\log_{10} I_0/I$ at various wavelengths and the absorption coefficient α_F at the F-band peak were determined. F-centre concentrations were computed from Smakula's formula using an oscillator strength of 0·8. In our experiments the density of F-centres was in the range 10^{17} to 10^{18}/cm^3.

RESULTS

X-ray irradiation and optical bleaching were carried out as explained before. Figure 1 represents optical bleaching curves for 'heat-treated' as well as 'as cleaved' NaCl crystals. Regions of fast and slow bleaching are clearly indicated in the case of heat-treated crystals. In our experiments, the optical bleaching curves can be explained by a simple relation of the form $\triangle\, \alpha_F/\alpha_{F_0} = k \log t$. Figure 2 shows a plot of $\triangle\, \alpha_F/\alpha_{F_0}$ *versus* log t for "as cleaved" NaCl crystals, $\triangle\, \alpha_F/\alpha_{F_0}$ being the fractional change in absorption coefficient at the F-band peak and t being the time of bleaching in minutes. Irrespective of X-ray irradiation time, the plot is a straight line. (Only 3 graphs are shown as samples.) In Fig. 3 the graph (*b*) represents the plot of $\triangle\, \alpha_F/\alpha_{F_0}$ *versus* log t for a heat-treated NaCl crystal and graph (*a*) represents that for an 'as cleaved' crystal. Graph (*b*) consists of two parts, one of which has got nearly the same slope as that of (*a*). We need at least two slopes to explain the bleaching curve obtained with heat-treated crystals. This indicates that the nature of bleaching in the initial stage is different from that in the later stage and that the mechanism of bleaching in the later stage is similar to that in the case of 'as cleaved' crystals.

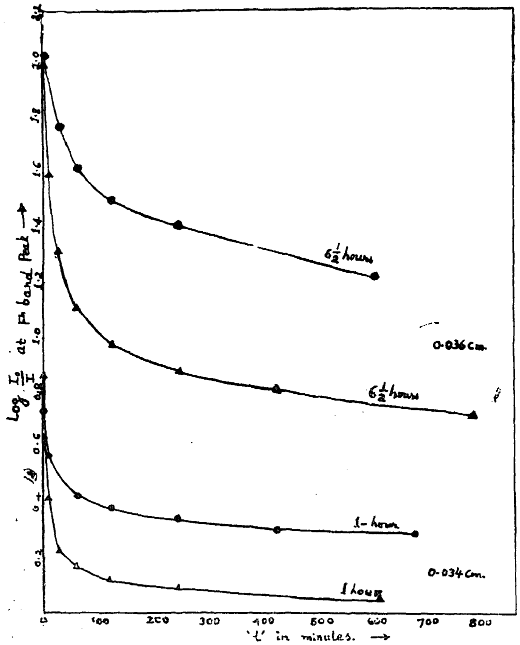


FIG. 1. Representing the optical bleaching curves for 'heat-treated' and 'as cleaved' NaCl crystals. ● Bleaching curves of 'as cleaved' NaCl crystals. △ Bleaching curves of 'heat-treated' NaCl crystals. Time of X-ray exposure and the thickness of the crystals are mentioned on the curves.

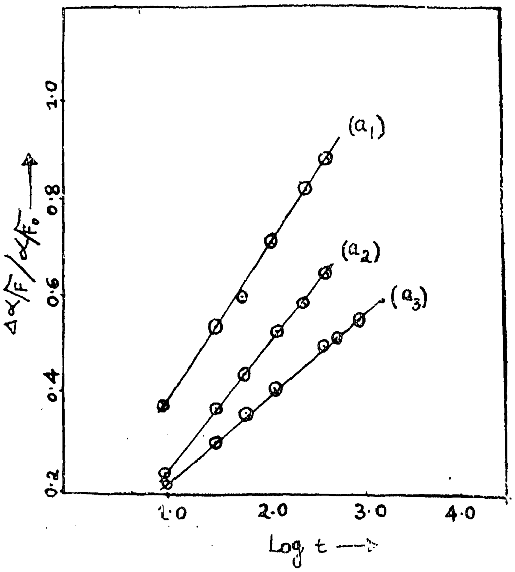


FIG. 2. Results obtained with 'as cleaved' NaCl crystals (a_1)—10 minutes X-ray irradiation. (a_2)—20 minutes X-ray irradiation. (a_3)—7 hours X-ray irradiation. Thickness of the crystal used = 0·034 cm.

DISCUSSION

To explain the mechanism of optical bleaching several theories have been put forward by earlier workers[1-10]. But a more rigorous one is that due to Bron and Nowick[13]. According to them the transfer of electrons from

F-centres to some pre-existing traps, present only in X-ray irradiated crystals (hole traps-V-centres which are produced along with F-centres in X-ray irradiated crystals), is considered to occur during the initial, very rapid part of the first stage of bleaching. Since the initial vacancies and hence the first type F-centres are widely distributed in the volume of the crystal, an ejected electron from an F-centre by a photon will have a very small chance of being recaptured by another vacancy before it combines with a hole trap. As the hole traps become fully occupied with electrons, bleaching becomes dependent on the rate of formation of the secondary centres like, R, M, N.

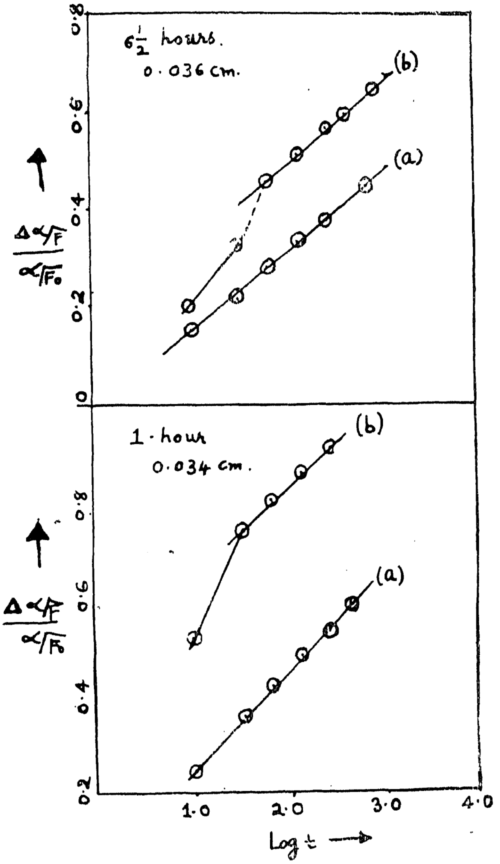


FIG. 3. A comparison of results obtained with 'as cleaved' and 'heat-treated' NaCl crystals (*a*) 'as cleaved' crystals; (*b*) 'heat-treated' crystals. X-ray irradiation time and the thickness of the crystals are mentioned on the graphs.

Since the second type F-centres have very high local density, it is not unreasonable that these F-centres should unite to form F-centre aggregates like M, N, R centres as they are bleached. The mechanism which slows down the second stage of bleaching will be as follows: The second type F-centres generated by X-rays during the second stage of coloration are of high concentration in certain localized areas of the crystal. During bleaching, a liberated electron will have a high probability of being recaptured by a nearby vacancy with no net loss of F-centre. Quantum efficiency measurements[6,12,13] also support the above mechanism of bleaching.

In 'as cleaved' crystals of NaCl, the number of vacancies present prior to irradiation is very much dependent on the origin of these crystals. In the case of Harshaw NaCl crystals, this number is of the order of 10^{15} to $10^{16}/cm^3$. (The same order of initial number of vacancies was estimated from graphical extrapolation for Harshaw NaCl crystals by Rabin[4] in his studies on expansion of colored NaCl crystals having different origins.) Thus the concentration of first type F-centres can be only of the order of 10^{15} to $10^{16}/cm^3$ or even less. In our experiments the density of F-centres is as high as $10^{17}/cm^3$ for X-irradiation of 10 minutes. When the crystal is being optically bleached, the first type F-centres are perhaps bleached within a few seconds and later the bleaching occurs only by forming F-centre aggregates like M, N, R centres. The study of absorption spectrum shows definitely that as the F-band decreases, the M-band gradually increases first and later the N-band appears at the expense of both F-band and M-band. So, the regions of fast first stage bleaching and the second stage bleaching are not separated out in the case of 'as cleaved' NaCl crystals as shown in Fig. 1. From Fig. 2 it is evident that the mechanism of bleaching is the same for all the 'as cleaved' crystals of NaCl irrespective of X-ray irradiation time and the only change observed is in their slope which decreases as the X-irradiation period increases. This can be explained from the fact that as the density of second type F-centres increases, the recapture of an ejected electron from an F-centre by a vacancy without net loss of F-centre becomes more prominent and hence the fractional change in absorption coefficient $\Delta\alpha_F/\alpha_0$ becomes much less for the given time of bleaching.

It is known that quenching of NaCl crystals at a particular temperature increases the initial number of vacancies. The effect is much greater at higher temperatures. This may be attributed to the 'quenching in' of vacancies which were in equilibrium at high temperatures. It is supposed that these vacancies are unable to coalesce. It is well established[3,6] that initial vacancies and those induced by heat treatment are similar and are widely distributed in the volume of the crystal. Thus in heat-treated crystal of NaCl, the concentration of the first type F-centres will enhance considerably when they are colored. Optical bleaching of these crystals clearly indicates that there are two distinct stages of bleaching. The rate of bleaching is faster in the initial stage and later the mechanism of bleaching is similar to that in the case of 'as cleaved' crystals.

In conclusion, it may be said that even though the regions of first stage and the second stage bleaching are not separated out in 'as cleaved' crystals of NaCl, distinct separation can be obtained by quenching the crystal at high temperatures. The results obtained from heat-treated NaCl crystal support the fact that the optical bleaching also takes place in two stages. Firstly, the fast bleaching of first type F-centres occurs and then in the second stage, the second type of F-centres are bleached with the formation of secondary centres like M, N, R.

ACKNOWLEDGEMENTS

One of the authors (K. V.) wishes to thank the Bangalore University for providing the Research facilities.

1. Seitz, F., *Rev. Mod. Phys.*, 1954, **26**, 7.
2. Gorden, R. B. and Nowick, A. S., *Phys. Rev.*, 1956, **101**, 977.
3. Nowick, A. S., *Phys. Rev.*, 1958, **111**, 16.
4. Rabin, H., *Ibid.*, 1959, **119**, 1381.
5. Bron, W. E., *Ibid.*, 1960, **116**, 1853.
6. Mitchell, P. V., Wiegand, D. A. and Smoluchowski, R., *Ibid.*, 1961, **121**, 484.
7. Kaplan, R and Bray, P. J., *Ibid.*, 1963, **129**, 1919.
8. Jain, S. C. and Mehendru, P. C., *Ibid.*, 1965, **140**, A 957.
9. Markham, J. J. Platt. T. Reuel, Jr. and Mador, L. Irving, *Ibid.*, 1953, **92**, 597.
10. Ueta, M. and Werner Kanzio, *Ibid.*, 1955, **97**, 1591.
11. Rabin, H and Klick, C. C., *Ibid.*, 1960, **117**, 1005.
12. Hesketh, R. V., *Phil. Mag.*, 1959, **4**, 114.
13. Bron, W. E. and Nowick, A. S., *Phys. Rev.*, 1960, **119**, 114.

DIRECTOR, RAMAN RESEARCH INSTITUTE

The Board of Trustees of the Raman Research Institute has appointed V. Radhakrishnan to the position of Director of the Institute. Radhakrishnan, who is at present with the CSIRO Division of Radio Physics in Sydney, is known for his significant contributions to Radio Astronomy for over a decade, particularly those relating to Pulsars, to interstellar neutral hydrogen and to Jupiter's radiation belt. He has been out of India for the last 18 years working in England, Sweden, the United States, and for the last 6 years, in Australia.

Radhakrishnan will be returning to India early next year to take up his appointment. Until then, S. Ramaseshan (Deputy Director, National Aeronautical Laboratory, Bangalore) will act for him and run the affairs of the Institute.

LETTERS TO THE EDITOR

SOME NEW RESULTS CONCERNING A SPHERICALLY SYMMETRIC METRIC OF THE GEODESIC TYPE

DURING the course of an investigation of the gravitational metric of the form

$$ds^2 = d\tau^2 - X^2(\rho, \tau)\, d\rho^2 - Y^2(\rho, \tau)\, d\Omega^2, \qquad (1)$$

where

$$d\Omega^2 = d\theta^2 + \sin^2\theta\, d\phi^2,$$

we have come across the metric

$$ds^2 = d\tau^2 - a^2(k-1)^2(a\rho + b\tau)^{2k/(k-1)}\, d\rho^2 - (k-1)^4(2k-1)^{-2}(a\rho + b\tau)^{2(2k-1)/(k-1)}\, d\Omega^2, \qquad (2)$$

where a, b and k are arbitrary constants.

We note the following points about the metric (2).

(i) It satisfies $X = \partial Y/\partial\rho$, the same relation is satisfied by (1) when it represents flat space-time in the usual form, that is, $X = 1$, $Y = \rho$.

(ii) The invariant[1] $I = (f_1f_4 - f_2^2)/f_3f_3$ is constant and is equal to k except when $k = 0$ or $k = 1$.

(iii) If $b = 0$, (2) gives flat space-time. The constant a can be absorbed in ρ by putting $\rho' = a\rho$.

(iv) The usual energy-momentum tensor components for (2) are

$$8\pi T_1^1 = 8\pi T_4^4 = b^2(2k-1)(4k-1)(k-1)^{-2}(a\rho + b\tau)^{-2},$$

$$8\pi T_2^2 = 8\pi T_3^3 = b^2 k(4k-1)(k-1)^{-2}(a\rho + b\tau)^{-2}.$$

All other components vanish.

If $k = \frac{1}{4}$, the metric (2) becomes

$$ds^2 = d\tau^2 - (9/16)\, a^2(a\rho + b\tau)^{-2/3}\, d\rho^2 - (81/64)(a\rho + b\tau)^{4/3}\, d\Omega^2 \qquad (3)$$

and $T_i^j = 0$ and hence it must be a transform of Schwarzschild's exterior solution

$$ds^2 = \left(1 - \frac{2m}{r}\right) dt^2 - \left(1 - \frac{2m}{r}\right)^{-1} dr^2 - r^2\, d\Omega^2, \qquad (4)$$

for which[1], also, $I = \frac{1}{4}$. It is found that the transformation

$$r = (9/8)(a\rho + b\tau)^{2/3}, \qquad (5)$$

$$t = \tau + 3\sqrt{m}\,(a\rho + b\tau)^{1/3} + 2m \log [(3/2\sqrt{2})(a\rho + b\tau)^{1/3} - \sqrt{2m}] \cdot [(3/2\sqrt{2})(a\rho + b\tau)^{1/3} + \sqrt{2m}]^{-1},$$

where

$b = (16/9)\sqrt{m}$, transforms (4) into (3).

The Jacobian of the transformation is

$$\partial(r, t)/\partial(\rho, \tau) = (3/4)\, a\, (a\rho + b\tau)^{-1/3} = 9a/8\sqrt{2r}.$$

Here we require m to be positive.

If $k = \frac{1}{3}$, T_i^j satisfy the Rainich algebraic conditions[2] $T_1^1 = T_4^4 = -T_2^2$ and $T_4^1 = T_1^4 = 0$ for a non-null electro-magnetic field to exist, and the metric now becomes

$$ds^2 = d\tau^2 - (4/9)\, a^2(a\rho + b\tau)^{-1}\, d\rho^2 - (16/9)(a\rho + b\tau)\, d\Omega^2. \qquad (6)$$

It is found that the transformation

$$r = (4/3)\sqrt{a\rho + b\tau},$$

$$t = \tau + \sqrt{\pi}\, e \log [(16/9)(a\rho + b\tau) - 4\pi e^2], \qquad (7)$$

where

$b = (9/4)\sqrt{\pi}\, e$, transforms the metric

$$ds^2 = \left(1 - \frac{4\pi e^2}{r^2}\right) dt^2 - \left(1 - \frac{4\pi e^2}{r^2}\right)^{-1} dr^2 - r^2\, d\Omega^2 \qquad (8)$$

into metric (6). The Jacobian of the transformation is

$$(2/3)\, a\, (a\rho + b\tau)^{-1/2} = (8/9)(a/r).$$

The space time will be flat if $e = 0$.

The metric (8) has a close resemblance with Nordstrom's solution with $m = 0$, *viz.*,

$$ds^2 = \left(1 + \frac{4\pi e^2}{r^2}\right) dt^2 - \left(1 + \frac{4\pi e^2}{r^2}\right)^{-1} dr^2 - r^2\, d\Omega^2 \qquad (9)$$

for which[1] also, $I = \frac{1}{3}$. However, (8) and (9) give altogether different gravitational situations.

The author wishes to thank Professor V. V. Narlikar, Lokmanya Tilak Professor of Applied Mathematics, for his guidance throughout the preparation of this note. Thanks are also due to the C.S.I.R., for the award of a Junior Research Fellowship which has made this work possible.

Department of Mathematics and Statistics,
University of Poona,
Poona, *July* 23, 1971.

P. P. KALE.

---

1. Prasanna, A. R., *Curr. Sci.*, 1969, **38**, 455.
2. Witten, L., *Gravitation: An Introduction to Current Research*, John Wiley & Sons, Inc., New York, London, 1962, p. 384.

THE NEW BAND SPECTRUM OF HAFNIUM MONOIODIDE

RECENTLY, Sivaji and Rao[1-3] have studied the spectra of ZrBr and ZrI and reported two complex systems of bands designated as C and B. The observed features of each of these systems appear to involve a transition of the type $^4\Pi$–$^4\Sigma$. More recently the same authors have reported the results of the vibrational analysis of two systems of TiBr attributed to the transitions A $^4\Pi$–X $^4\Sigma$ and C $^4\Pi$–X $^4\Sigma$. In TiI two band systems ascribed to the transitions A $^4\Pi$–X $^4\Sigma$ and B $^4\Pi$–X $^4\Sigma$ have been reported. In order to extend our knowledge of these spectra, a search has been made for the spectra of the homologous molecules HfI and HfBr.

A new band spectrum attributable to HfI has been obtained in emission in the radiofrequency discharge from a ½ K.W. oscillator and photographed under the first order dispersion (1·25 Å mm^{-1}) of a 21 ft. concave grating spectrograph. The spectrum of HfI reveals discrete groups of bands in two spectral regions λ 5080–λ 4920 Å and λ 4890–λ 4820 Å. The groups of bands shown in strips (*a*), (*b*), (*c*) and (*d*) of Fig. 1 are assigned to a system designated as system C. The groups of bands shown in strips (*e*) and (*f*) of Fig. 1 are assigned to another system designated as system B. By analogy with systems C and B of ZrBr and ZrI each of the systems has been attributed to a $^4\Pi$–$^4\Sigma$ transition.

System C.—System C shown in strips (*a*), (*b*), (*c*) and (*d*) of Fig. 1 consists of four groups of line-like bands in the region λ 5080–λ 4920 Å, with separations of 88 cm^{-1}, 161 cm^{-1} and 236 cm^{-1} between adjacent groups. From the region of occurrence of the system and the line-like appearance of the band heads in each group, the system can be regarded as analogous to system C of ZrI. Each group is interpreted as the (0, 0) sequence of one of the multiplet components of a $^4\Pi$–$^4\Sigma$ transition. In general two types of heads designated as α and β are observed as in system C of ZrCl[4], ZrBr and ZrI. The line-like α heads observed in each group are interpreted as the Q heads of a (0, 0) sequence. In two of the groups the β heads which are not well developed and appear weak are identified as shown in strips (*a*) and (*c*) of Fig. 1. The occurrence of intense line-like Q heads suggests that the B values in the initial and final states must be very nearly equal. A peculiar feature of each sequence shown in strips (*a*), (*b*) and (*c*) is that while the Q heads are degraded to shorter wavelengths, the vibrational structure is degraded to longer wavelengths. In the (0, 0) sequence shown in strip (*d*), both the Q heads and vibrational structure are degraded to longer wavelengths. As the separation between successive Q heads in each sequence is approximately 7 cm^{-1} and as the vibrational structure of the bands in each sequence is degraded towards longer wavelengths, ω_e' is less than ω_e'' by about 7 cm^{-1}. No outside sequences $\Delta v = \pm 1$ are observed which can reasonably be attributed to the fact that the B_e and r_e values are almost equal in the upper and lower states. The measurements and classification of the band heads are shown in Table I.

TABLE I

List of vacuum wavenumbers and intensities of band heads in system C of HfI

Wavenumber cm^{-1}	Intensity I*	Classification
19750·6 R	4	5, 5 α
57·8 R	5	4. 4 α
64·6 R	6	3, 3 α
71·1 R	7	2, 2 α
78·2 R	7	1. 1 α
85·3 R	7	0, 0 α
20002·1 V†	4	4, 4 α
06·5 V†	4	3, 3 α
11·7 V	5	2, 2 α
17·0 V	5	1, 1 α
21·1 V	6	0 0 α
24·5 V	2	β
31·4 V	1	β
20156·6 V	3	3, 3 α
65·5 V	3	2, 2 α
73·8 V	3	1, 1 α
81·9 V	4	0, 0 α
20255·5 V	3	3, 3 α
61·2 V	3	2 ,2 α
65·9 V	4	1, 1 α
69·8 V	6	0, 0 α
72·8 V	2	β
79·9 V	1	β

* The intensities quoted here are visual estimates based on a scale 0–10.

(†) Superposed by atomic line. R—Degraded to Red. V—Degraded to Violet.

System B.—The four groups of bands reproduced in strips (*e*) and (*f*) of Fig. 1 are ascribed to another system designated as B. From the region of occurrence of the system, it appears that this system is analogous to system B of ZrBr and ZrI ascribed to the transition $^4\Pi$–$^4\Sigma$. The two groups of bands shown in strip (*f*) of Fig. 1 are interpreted as R and Q heads of a (0, 0) sequence of one of the multiplet components of a $^4\Pi$–$^4\Sigma$ transition. As the separation between successive Q heads is 2 cm^{-1} and as the bands are degraded to

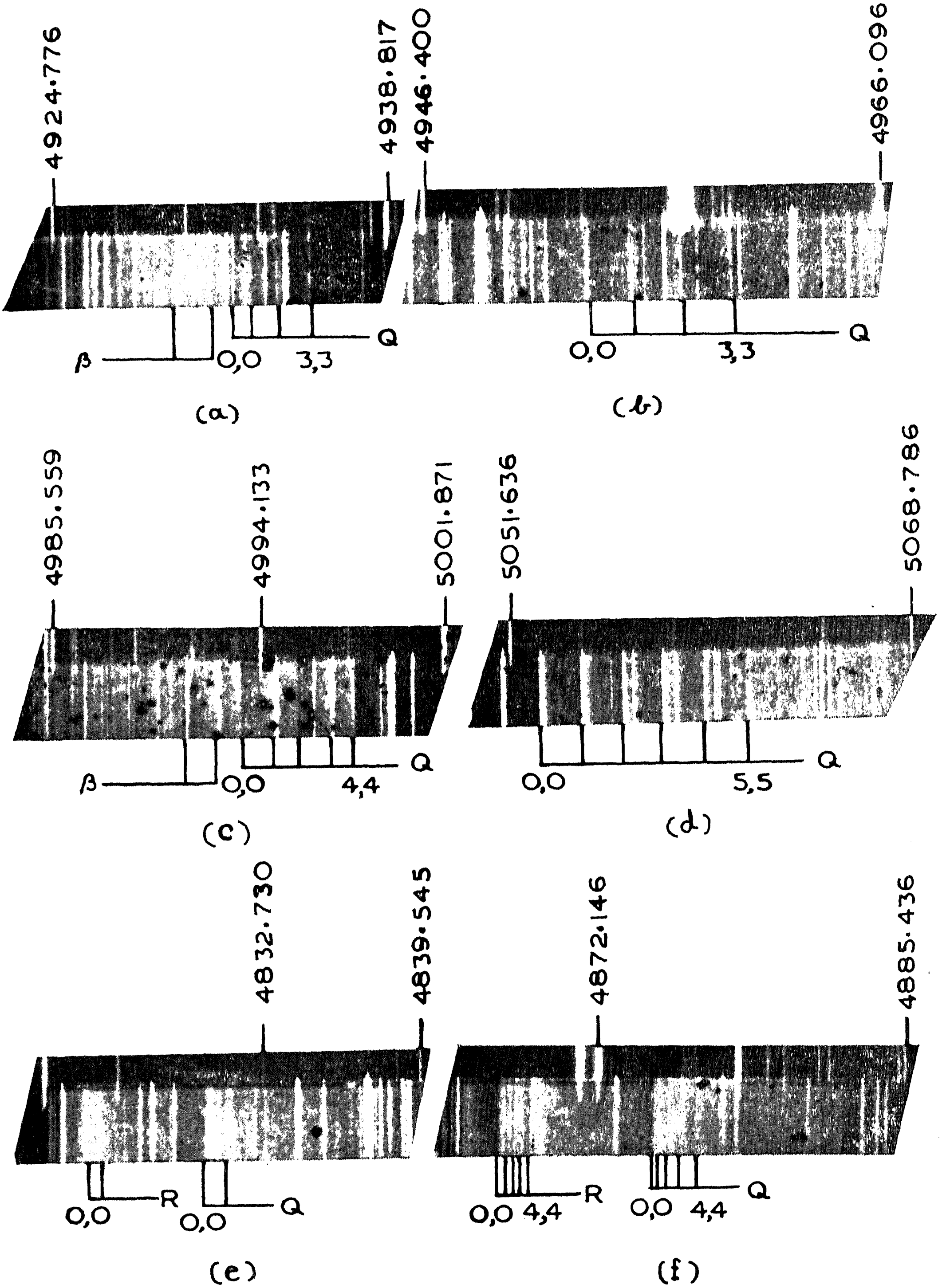


FIG. 1 (a), (b), (c) and (d). Grating spectrograms of (0, 0) sequences of $C^4\Pi - {}^4\Sigma$ system. (e) and (f) Grating spectrograms of (0, 0) sequences of $B^4\Pi - {}^4\Sigma$ system.

longer wavelengths, ω_e' is less than ω_e'' by about two wavenumber units. The separation between R and Q heads in each band is observed to be large (about 28 cm^{-1}). The large separation is due to the fact that the B′ and B″ values in the upper and lower states are almost equal. The two groups of bands shown in strip (*e*) of Fig. 1 are interpreted as the R and Q heads of the second multiplet component of the $^4\Pi$–$^4\Sigma$ transition. The two remaining component systems are not observed in system B of HfI. As the corrresponding heads (Q and R) in each component system are separated by a wavenumber interval of 183 cm^{-1} the coupling constant A in the upper $^4\Pi$ state is about 183 cm^{-1} No outside sequences of $\Delta v = \pm 1$ are observed because of the near equality of B_e and ω_e values in the upper and lower states. The measurements and classifications of the band heads are given in Table II.

TABLE II

List of vacuum wavenumbers and intensites of band heads in system B of HfI

Wavenumber cm^{-1}	Intensity I*	Classification
20501·0 R	10	4, 4
04·0 R	10	3, 3
06·4 R	9	2, 2
08·1 R	10	1, 1
08·8 R	9	0, 0
31·4 R	8	4, 4
33·3 R	7	3, 3
34·4 R	7	2, 2
35·8 R	7	1, 1
37·4 R	7	0, 0
20693·2	3	1, 1
95·5	4	0, 0
715·4	5	1, 1
17·8	5	0, 0

* The intensities quoted here are visual estimates based on a scale 0–10.

R—Degraded to Red,

One might consider the two component systems belonging to a transition of the type $^2\Pi$–$^2\Sigma$ with a doublet separation of 183 cm^{-1} for the upper $^2\Pi$ state. Such a transition was not however observed in the spectra of TiBr, ZrBr and ZrI. Instead, system ascribed to $^4\Pi$–X $^4\Sigma$ has been observed. It appears therefore reasonable to attribute that the two systems arise from two components of a $^4\Pi$–$^4\Sigma$ transition.

One of the authors (T. S.) is grateful to the Council of Scientific and Industrial Research, New Delhi, India, for their financial assistance in carrying out this programme of work.

Physics Department, Andhra University, Waltair (India), *July* 31, 1971.

T. SAVITHRY.
D. V. K. RAO.
P. T. RAO.

---

1. Sivaji, Ch. and Rao, P. T, *Proc. R. Ir. Acad.*, 1970, **70 A**, 1.
2. — and —, *J. Phys.* (Lond.), 1970, **3B**, 720.
3. —. Rao. D. V. K. and Rao, P. T., *Curr. Sci.*, 1970, **39**, 153.
4. Carroll, P. K. and Daly, P. J., *Proc. R. Ir. Acad.*, 1961, **61 A**, 101.

A RAPID METHOD FOR DETERMINATION OF TISSUE POTASSIUM IN ARECANUT

ABSTRACT

The efficiency of different extractants which included cold water, hot water, salt solutions, chelate and dilute acid to extract potassium from areca leaf was compared with the wet oxidation procedure. Amongst the various extractants employed, hot water gave the best result. Hot water also eliminates the possibility of contamination from impure chemicals. The method is rapid, handy, accurate and inexpensive.

EXTRACTION of potassium from plant tissue is usually made by wet oxidation, dry ashing and direct leaching with ammonium acetate. The element extracted is estimated either by flame photometry or conventional cobaltinitrite method. There are certain serious drawbacks associated with these two procedures of ashing. Loss of considerable amount of potassium takes place at the temperature range of 550°–600° C while dry ashing. Although the same could be avoided at lower temperature of 400°–450° C, the method is time-consuming. The wet ashing procedure requires special fume exhaustion arrangements for carrying out the digestion. In view of these difficulties, it is desirable to choose the leaching method of extraction. This would enlarge the scope of handling more number of samples per day.

Jackson[1] proposed the use of 2 *N* NH_4 OAc + 0·2 *N* Mg $(OAc)_2$ as the solution for extraction of potassium from plant tissue. We in this laboratory attempted to evaluate the potassium extracting abilities of several extractants namely, water, hot water, acidified water of pH 4·5, 2 *N* NH_4OAc, 2 *N* Mg $(OAc)_2$, 2 *N* NH_4 OAc + 0·2 *N* Mg $(OAc)_2$, 0·02 *M* di-sodium EDTA, 0·1 *N* HCl from tissue samples in relation to the wet oxidation method which was considered as the standard. The ratio of tissue to extraction solution employed was 1 : 200. The leaf samples used in the present study were collected from the NPK manurial experimental area of

TABLE I

Comparison of different extraction procedures for potassium in areca leaf

(Results expressed on oven dry basis as percentage of K)

Sample No.	Wet oxidation	Water	Hot water	Water pH 4·5	2 N NH_4OAc	2 N $Mg(OAc)_2$	2 N NH_4OAc + 0·2 N $Mg(OAc)_2$	0·02 M EDTA	0·1 N HCl
1	0·79	0·75	0·76	0·69	0·68	0·60	0·65	0·66	0·79
2	0·76	0·78	0·70	0·71	0·71	0·64	0·66	0·70	0·61
3	0·52	0·50	0·48	0·44	0·44	0·40	0·44	0·49	0·41
4	0·52	0·51	0·53	0·47	0·48	0·42	0·48	0·46	0·44
5	0·98	0·92	0·96	0·91	0·85	0·82	0·87	0·85	0·79
6	0·79	0·72	0·79	0·74	0·66	0·63	0·71	0·71	0·62
7	0·68	0·64	0·66	0·63	0·61	0·56	0·61	0·61	0·51
8	0·98	0·94	0·98	0·89	0·85	0·81	0·90	0·88	0·81
9	1·16	0·98	1·04	1·06	0·96	0·90	1·02	1·02	0·94
10	0·50	0·42	0·49	0·44	0·48	0·42	0·44	0·44	0·40
11	1·21	1·13	1·26	1·17	1·11	1·04	1·15	1·15	1·08
12	1·10	0·98	1·09	1·04	0·98	0·94	1·01	1·00	0·93
't' value:		4·140 NS	1·733 NS	10·941*	6·920*	10·951*	9·798*	8·573*	8·086*

* Significant at 0·1% level of probability, NS = Non-significant.

the Institute, oven-dried and ground by a rotary mill. A 0·5 g of the tissue sample was treated with 100 ml of the extractant solution and shaken for 1 hr. In the case of wet ashing method, the same weight of the leaf material was pre-digested with nitric acid over a water-bath and subsequently treated with 10 ml of 1 : 1 nitric to perchloric acid mixture till the content was clear and just moist (Perur, personal communication). In all the cases, from an aliquot potassium was read by Systronix flame photometer.

The results of the study are summarized in Table I along with the statistical constants. Potassium extracted by water and hot water did not differ significantly from that of wet oxidation method. However, when the paired 't' values were compared, out of all hot water was found to be the most suitable extractant.

The efficiency of water to extract potassium from plant sample is an established fact. Potash-free ash is obtained when the plant tissue is extracted with cold water[2]. This is possible because the potassium in plant cell is mostly present in the form of inorganic compounds and salts of organic acids. The superior performance of hot water over cold appears to be due to the greater solvent property of the former. Besides, hot water may expand the cell walls of the tissue and make them more permeable. The proposed method is simple, handy, rapid and may be useful for the routine analysis when problems exclusively relating to potassium nutrition of crops are involved.

Thanks are due to Mr. K. Shama Bhat, Arecanut Specialist and Mr. K. V. Ahamed Bavappa, Director of the Central Plantation Crops Research Institute, for providing necessary facilities and encouragement.

Department of Soils,
Central Plantation Crops
Research Institute,
Regional Station, Vittal,
May 7, 1971.

A. R. MOHAPATRA.
N. T. BHAT.
V. O. ABOOBAKER.

---

1. Jackson, M. L., *Soil Chemical Analysis*, Prentice-Hall of India, Private Ltd., New Delhi, 1967, p. 333.
2. Miller, E. C., *Plant Physiology*, McGraw-Hill Book Company, Inc., New York and London, 1938, p. 317.

ON THE OCCURRENCE OF AN INTERSEXUAL FORM AND POSSIBLY A NEW SPECIES OF *APHELENCHOIDES* FISCHER (NEMATODA : TYLENCHIDA)

OCCURRENCE of intersexes in nematodes is known in relatively few genera. In the order Tylenchida, it has been reported only thrice (Chitwood, 1949 ; Hirschmann and Sasser, 1955 ; Triantaphyllou, 1960). This is the fourth record of an intersex in Tylenchida and the first in the genus *Aphelenchoides* Fischer, 1894.

Except in *Meloidogyne* spp., the intersexes in all other groups of nematodes have been females which showed secondary male characters. These intersexes had well-developed female gonad (s) with duct (s), vagina and vulva. In addition, they possessed male sexual opening, spicules, cloacal papillae, etc.

The male intersexual form was first reported by Chitwood (1949) in *Meloidogyne javanica* (Treub). Triantaphyllou (1960) found that the male intersexes of *M. javanica* and

M. incognita Chitwood were derived from second stage female larvae through sex reversal. Whereas the true males possessed one testis, the intersexes had two testes corresponding to the two ovaries of the female. This sex reversal was ascribed to conditions unfavourable for normal rate of propagation of the nematode.

The present specimen, a female intersex, differs from both these species in being much smaller in size and in the excretory pore and nerve ring being situated at the same level (excretory pore posterior to nerve ring in *hilophilus* and anterior in *subparietinus*). It further differs from *A. hilophilus* in possessing poorly developed stylet knobs and from *A. subparietinus* in having a post-vulvar uterine sac which is slightly longer than the body width (4–5 times body width in *subparietinus*).

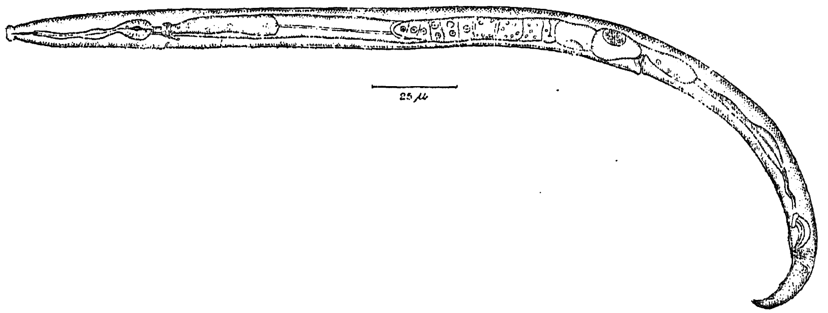


FIG. 1. *Aphelenchoides* sp., intersex.

Material.—Single specimen, collected from rhizosphere of paddy (*Oryza* sp.) at Mourigram, Andul, Distt. Howrah, W.B., on 14-9-1970.

Description:

Intersex: L = 0·339 mm; $a = 24$; $b = 6\cdot5$; $b' = 3\cdot8$;

$a = 14$; $V = {}^{26}66^{5}$; stylet = 8·4 µ.

Posterior end narrow and curved ventrally. Tail 24 µ long, carrying a large, ventrally situated mucron. Cuticle with fine transverse striations; lateral fields and incisures absent. Head offset, 2·8 µ high and 4·2 µ wide. Stylet with poorly developed knobs. Procorups of oesophagus narrow 29 µ long; median bulb prominent 13 × 7 µ. Oesophageal glands lobe lying free, dorsally in the body and joining the alimentary canal behind the median bulb. Nerve ring and excretory pore at the same level, 53 µ from anterior end.

Ovary single, outstretched. Oöcytes arranged in single row after the cap cell, in two rows thereafter and again in single row in the growth zone. Post-vulvar uterine sac, 10 µ long, contains a few round sperm.

Testis absent. Two typically aphelenchoid spicules, dorsal limb 11 µ, ventral limb 7 µ long, latter almost reaching tip of dorsal limb. Two pairs of inconspicuous, post-cloacal, subventral papillae.

Discussion.—So far only two species of *Aphelenchoides* are known without lateral fields and incisures, *viz.*, *A. hilophilus* (de Man, 1880) and *A. subparietinus* (Sanwal, 1961).

Hirschmann and Sasser (1955) compared the intersexes with normal individuals and showed that intersexuality had little effect on body dimensions. Yet, with only one specimen at disposal, and that too an intersex, we feel hesitant to erect a new species for it.

We thank Dr. A. P. Kapur, Director, Zoological Survey of India, for providing facilities.

Zoological Survey of India, S. KHERA.
8, Lindsay Street, Y. CHATURVEDI.
Calcutta, *May* 17, 1971.

---

1. Chitwood, B. G., *Proc. helminth. Soc. Wash.*, **1949**, **16** (2), 90.
2. De Man, J. G., *Tijdschr. Ned. Direk.*, 1880, **5**, **1**,
3. Hirschmann, H. and Sasser, J. N., *Proc. helminth. Soc. Wash.*, **22** (2), 115.
4. Sanwal K. C., *Can. J. Zool.*, 1961. **39**, 573.
5. Triantaphyllon, A. C., *Ann. Inst. Phytopath. Benaki*, N. S. **3** (1), 12.

AN INSTANCE OF HERMAPHRODITISM IN THE RIBBON-FISH, *TRICHIURUS LEPTURUS* LINNAEUS

THE rare phenomenon of hermaphroditism in fishes has been recorded only from a few groups as cited by Raju[2] and Kagwade[1]. During the course of work on the biology and fishery of the ribbon-fish, *Trichiurus lepturus* Linnaeus off Mangalore along the west coast of India, the author came across a hermaphrodite specimen and since this is the first instance in this species, the details are given here. The specimen has been deposited in the Museum of the Fisheries College, Mangalore.

The gonads in this species are elongated and closely approximated to appear as a single unit. The right gonad is larger than the left, the former forming a loop over the latter at the anterior end.

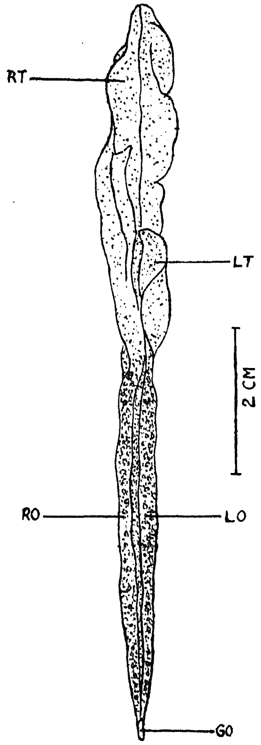


FIG. 1. Hermaphroditic gonads of *Trichiurus lepturus* Linnaeus, (GO: Genital opening; LO, LT: Ovarian and testicular parts of left gonad; RO, RT: Ovarian and testicular parts of right gonad).

In the hermaphrodite specimen, 215 mm snout-vent length, 616 mm standard length, 144 gm weight collected from trawl fish catch off Mangalore on 2-12-1970, both the gonads were found to be ovo-testes (Fig. 1). The right gonad was 101 mm long of which the anterior 52 mm was testis and the posterior 49 mm was ovary. The left gonad was 69 mm long consisting of anterior 20 mm testis and posterior 49 mm ovary. The gonads together were 7 mm wide at the anterior end (testicular part) and 4 mm at the posterior end (ovarian part). Microscopic examination revealed presence of ova upto a maximum size of 0·64 mm in the ovarian part and maturing condition of spermatozoa in the testicular part. The ovarian and testicular parts of the ovo-testis could be easily identified macroscopically by their distinctive colouration, the former being light yellow and the latter creamy-white. The specimen did not show any abnormality both in external appearance and general internal anatomy. The other specimens in the sample included both males and females in immature, maturing, mature, ripe, partially spent and spent gonadic condition.

Fisheries College, P. S. B. R. James.
University of Agricultural Sciences,
Mangalore-1, *June* 12, 1971.

---

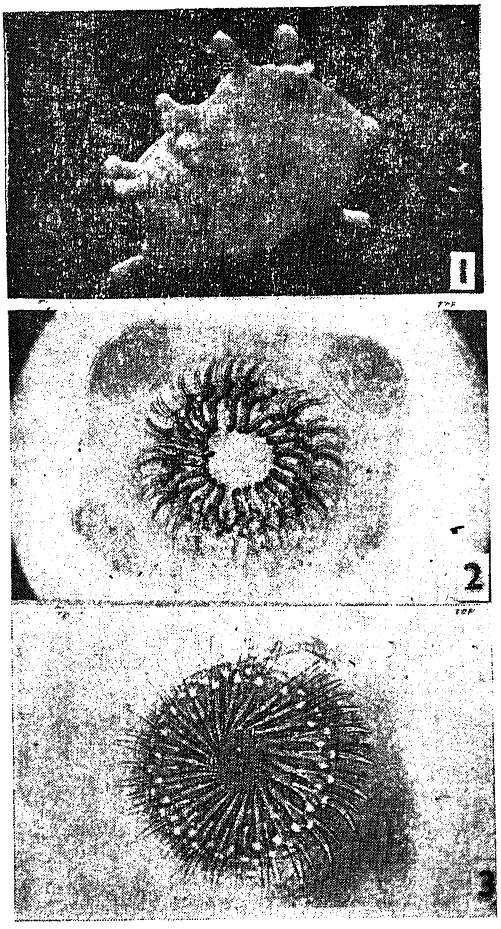
1. Kagwade, P. V., "Hermaphroditism in *Polydactylus indicus* (Shaw)," *J. Mar. biol. Ass. India*, 1970, **10** (2), 399.
2. Raju, G., "A case of hermaphroditism and some other gonadal abnormalities in the skipjak *Katsuwonus pelamis* (Linnaeus)," *Ibid.*, 1960, **2** (1), 95.

COENURUS SP., FROM THE PERITONEAL CAVITY OF THE GERBIL, *TATERA INDICA* (HARDWICKE) IN MADRAS*

Of all the Taeniid larval forms known, the Coenurus is found only in the genus *Multiceps*, parasitic in the dog. The intermediate host and the site of parasitization by the Coenurus have long been considered to be distinctive criteria for the identification of the species : *Coenurus cerebralis* in the brain of sheep, *C. gaigeri* in the subcutaneous tissues of the goat, and *C. serialis* in the subcutaneous tissues of rodents and rabbits, though exceptionally they may be encountered elsewhere or in other hosts. These have been relied upon for the distinction of *Multiceps* species by several authors[1-3].

It is evident from the available literature that any Coenurus occurring in a rodents would reasonably be identified as *C. serialis*, and this indeed seems to have been done in some cases, even disregarding structural variations. Recent studies have, however, involved a closer study of the hook size, shape and number, both of the adult worms and their coenuri, to the extent that speciation in the genus *Multiceps* has become difficult and frequently hypothetical. Clapham[4] held that *M. serialis* was only a variant of *M. multiceps*, and therefore not a valid species. Nagaty and Ezzat[5] were of the opinion that *M. gaigeri*, as described by Hall[6], was also of doubtful status. In experimental infections on goat kids and lambs, with eggs of *M. gaigeri* raised in a dog from *Coenurus gaigeri* in the subcutaneous tissue of a goat, Rao[7] found that the coenuri chose different situations in the two hosts, namely, the subcutaneous tissue in the goat kid and the brain in the lamb. Thus, the distinction of *M. multiceps* from *M. gaigeri* based on the location of the Coenurus and the identity of the intermediate host would appear to be ill-founded. Larsh, Race and Esch[8] had also reported upon experimental infection of *C. serialis* in the brain of white mice.

In the present study, a Coenurus 1·10 × 0·80 cm in size was detected in the peritoneal cavity of one of 322 gerbils, *Tatera indica* (Hardwicke) examined in January 1970 (Fig. 1). It bore 23 scolices irregularly disposed on the outer aspect of the cyst wall, all of which had evaginated while in normal saline. A few (10) scolices were excised, stained in a modified Trichrome stain, and mounted for study. The hooks were arranged in a typical corona, and appeared in two sets, one of the larger variety and the other smaller. Their number was **44** (22 + 22) in most of the scolices (Fig. 2), though it varied in a few. Out of 10 scolices examined for this purpose, 6 had 44 (22 pairs), one had 40 (20 pairs), another 46 (23 pairs), and 2 had 45 (23 large and 22 small); the last group with 45 (Fig. 3) showed a gap in the circle suggestive of a small hook having dropped out. The larger hooks measured **320–330** microns, and the smaller ones 207–221 microns. The handle of the larger hook was sinuous and longer than the blade.



FIGS. 1–3. Fig. 1. Photograph of entire Coenurus showing evaginated scolices. × 3·1. Fig. 2. Photomicrograph of rostellum showing a crown of the normal number of hooks (44). × 31. Fig. 3. Photomicrograph of rostellum showing 45 (23+22) hooks, × 47.

On a consideration of its identity, it is observed that the normal hook number (44) is in excess of the maximum number present in any of the three species of *Multiceps* known in this country, as adults or coenuri, namely, 22–32 in *M. multiceps*, 28–32 in *M. gaigeri*, and 26–32 in *M. serialis* according to Southwell[1], Wardle and McLeod[9] and Rao *et al.*[3].

According to Wardle and McLeod[9] and Yamaguti[10], coenuri reported from the gerbil and other rodent hosts are: *M. serialis* from *Gerbillus hirtipes*; *M. brauni* from *Gerbillus pyramidum* and other rodents in East Africa; *M. endothoracicus* from *Meriones, Gerbillus* etc., in Europe, Morocco, Iran and Kazhakistan; *M. glomeratus* from *Gerbillus hirtipes* in Tunis; *M. macracantha* from white rats in S. Rhodesia; *M. otomys* from *Otomys erroratus* in Pretoria; *M. parviuncinatus* from *Citellus xanthoprymnus* in America, and *M. radians* from a mouse in France. There are no prior records of the occurrence of the *Coenurus* sp. in rodents in India.

Of the above, descriptions of the species *M. endothoracicus* and *M. parviuncinatus* have not been available to the author. But, all the others listed and other known species of *Multiceps* have been considered by Johri[11] in distinguishing *M. smythi* (a new species recovered as an adult from dogs in Dublin, Eire) from them, as one possessing 44 hooks on the rostellum. Referring to the only other species with the same number of hooks, he stated that "the polycephalic larva (*Hydatigera taeniaeformis* of Southwell and Kirshner, 1937), which is the larval form of *M. crassiceps*, is the only form in which the number of rostellar hooks is exactly the same as it is in the species here described, but in the former the hooks are enormously enlarged and show a great contrast".

The Coenurus herein reported is identical with these two species in respect of the number of rostellar hooks, but the size of the hooks differs from either of them. While in *M. smythi*, the larger hook measures 220–238 microns, and the smaller one 140–150 microns, and in *M. crassiceps* they are 380–400 and 220–240 microns, in the present form they are 320–330 and 207–221 microns.

The specific status of the present *Coenurus*, as identical with that of *M. smythi* or *M. crassiceps*, or of an undescribed one, will depend on the morphology of the adult worm to be raised experimentally on a future occasion.

This work is part of a study conducted in the Department of Parasitology, Madras Veterinary College, as a doctoral condidate, and my grateful thanks are due to Professor M. Anantaraman for valuable guidance, and to Dr. V. S. Alwar, Professor of Parasitology, Madras Veterinary College, and the Director of Veterinary Education and Research and Dean, Madras Veterinary College, for facilities and encouragement.

Dept. of Parasitology, E. EBENEZER RAJA.
Madras Veterinary College,
Madras-7, *March* 31, 1971.

---

* Approved for publication by the Research Council, Madras Veterinary College.

1. Southwell. T., *Fauna of British Inda*, Cestoda, 1930, **1**,
2. Bhalerao, G. D., *Indian Council of Agricultural Research Monograph*, 1935 **10**,
3. Rao, S. R., Bhatavdekar, M. Y. and Detha, K. J., *Bombay vet. Coll. Magazine*, 1957, **6**, 12.
4. Clapham, P. A, *J. Helminth.*, 1942, **20**, 25.
5. Nagaty, H. F. and Ezzat. M. A. E, *Proc. Helm. Soc. Wash.*, 1946, **13**, 33.
6. Hall, M. C., *J. Amer. vet. Med. Assoc.*, 1916, **50**, 214.
7. Rao B. V., *Proc. Summer Inst. Paras.*, IVRI, 1968, p. 6.
8. Larsh, J. E., Race, G. J. and Esch. G. W., *J. Parasitol.*, 1965, **51**, 45.
9. Wardle, R. A. and McLeod. J. A., *The Zoology of Tapeworms*, Univ. Minn. Press, 1952.
10. Yamaguti, S., *Systema Helminthum*, Cestodes of Vertebrates, 1959.
11. Johri, L. N., *Parasitology*, 1957, **47**, 16.

A NEW RECORD OF *TRICHOGRAMMATOIDEA* SP. (HYMENOPTERA : TRICHOGRAMMATIDAE) AS A PARASITE OF THE SCIOMYZID FLY *SEPEDON SAUTERI* HENDEL

Sepedon sauteri Hendel is a very common sciomyzid fly developing on the snail *Radix luteola* (Lamarck) occurring in paddy fields and swamps around Bangalore. The eggs of this fly are known to be parasitized in Japan by *Trichogramma japonicum* Ashmead which is an important egg parasite of the rice stem borers, *Chilo suppressalis* (Walker) and *Tryporyza incertulas* (Walker) and thus the fly functions as an important alternate host of the wasp particularly when the eggs of the rice stem borers are scarce or absent in the fields (Yasumatsu, 1967).

During a recent study of the biology of *S. sauteri* made in Bangalore it was found that the eggs of this fly were parasitized by a species of *Trichogrammatoidea* which was identified as probably *nana* (Zehnt.) (Fig. 1). *T. nana* has been reported under the name *Trichogramma nana* (Gir.) from Fiji, Sumatra, Dutch East Indies, Java, Formosa, Philippines, Ceylon and Malaya on the eggs of various hosts belonging to Lepidoptera and one species of Coleoptera (Thompson, 1958). Eggs of *S. sauteri* were laid in compact masses, each group consisting of 9–36 eggs arranged side by side in one row in the form of a raft. Eggs collected around Bangalore during December 1969 were seen to be parasitized to the extent of 75% of egg-masses. The parasitized egg-masses showed

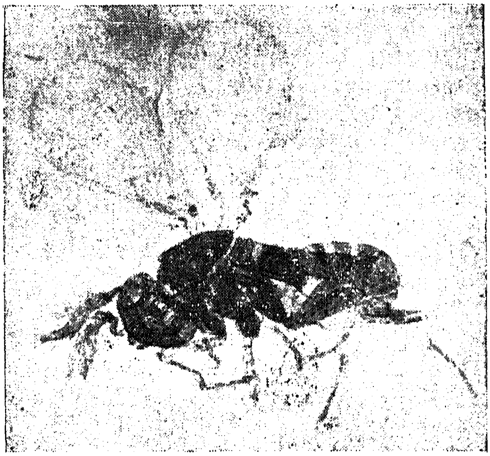


FIG. 1. *Trichogrammatoidea* sp. probably *nana* (adult).

that most of the eggs in each mass were parasitized giving about 65% of parasitization in all. More than one parasite emerged from each parasitized egg through neatly cut circular holes in host eggs (Fig. 2). The parasitized eggs appeared whitish in colour as against the pale brown colour of healthy eggs.

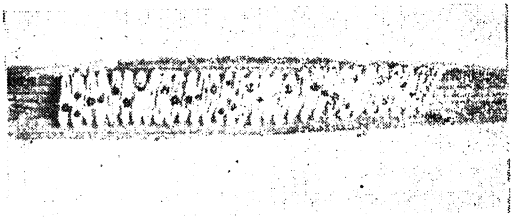


FIG. 2. Egg-mass of *Sepedon sauteri* showing emergence holes of the parasites (*Trichogrammatoidea* sp).

Attempts were made with complete success to rear the parasite on the eggs of the flour moth, *Corcyra cephalonica* Stainton, reared on broken sorghum grains. Fresh eggs of *C. cephalonica* glued to paper strips in a single tier were exposed to the parasite in specimen tubes. The females were seen to readily oviposit in the eggs of *Corcyra*, and they were also seen to feed at the oviposition punctures. The parasitized eggs were noticed to blacken by the fourth or the fifth day after exposure to adult parasites indicating successful parasitization. The total life-cycle of the parasite on *Corcyra* eggs took 11 days. Only one parasite emerged from each egg.

The parasite reported here was identified by Dr. Sudha Nagarkatti, Commonwealth Institute of Biological Control, Bangalore, whose courtesy is gratefully acknowledged.

Dept. of Entomology, G. P. CHANNABASAVANNA.
Agricultural College, Hebbal, K. DURGA PRASAD.
Bangalore-24, *May* 11, 1971.

---

1. Thompson, W. R., *A Catalogue of Parasites and Predators of Insect Pests*. Commonwealth Inst. Biol. Control Canada. 1958, Sec. 2 (5), p. 698.
2. Yasumatsu, K., "Distribution and bionomics of natural enemies of rice stem borers (Research on the natural enemies of rice stem borers)," *Mushi*, 1967, 39, Suppl., 33.

END-OF-SEASON BREAKDOWN OF SELF-INCOMPATIBILITY IN *SOLANUM CHACOENSE**

MARKS[1] had first observed self-set berries at the end of the plant's growing season in evenploid species of *Solanum*, in the series Longipedicellata, Demissa, Conicibaccata and Piurana, where hand pollination of the same plants earlier in the season failed or gave berries with few seeds. These species he, therefore, considered to be self-incompatible, but to show an end-of-season fertility. Here we report the occurrence of end-of-season fertility in an otherwise self-incompatible diploid species *Solanum chacoense*, in the series Commersoniana.

The plants were raised from tubers planted in the middle of April, 1969. The setting of berries was observed in the months of September-October, whereas on selfing early in the season no setting of berries could be obtained. The data on the number of self-set berries and the average number of seeds produced per berry in nine clones of *S. chacoense*, are given in Table I. In clone SS 676–4, there was highest percentage of berries set and maximum average number of seeds per berry, whereas the lowest percentage of berry set was in the clone SS 680–4, and the minimum average number of seeds per berry was obtained in clone SS 693–1.

TABLE I

No.	Acc. No †	No. of berries/ No. of flowers	% berries set	Av. No. of seeds per berry
1	S.S. 276–54 (WRF 337)	7/25	28·0	77·1
2	S.S. 676-3 (PI209412)	3/25	12·0	52·3
3	S.S. 676–4 (PI209412)	11/20	55·0	137·7
4	S.S. 676–5 (PI209412)	1/15	6·67	45·0
5	S.S. 676–11 (PI209412)	6/30	20·0	81·7
6	S.S. 680–4 (PI275138)	1/25	4·0	50·0
7	S.S. 684-2 (PI320283)	8/25	32·0	45·6
8	S.S. 685–1 (PI320291)	2/20	10·0	45·0
9	S.S. 693–1 (PI320288)	12/30	40·0	11·6

† S.S. No. indicate the accession numbers of the Central Potato Research Institute. The numbers given in the parenthesis are those of the Potato Introduction Station, Sturgeon Bay, Wis., U.S.A.

This phenomenon of self-fertilization in otherwise self-incompatible species at the end of the season has a bearing on the physiology of the mechanism of self-incompatibility in *Solanum* species. The breakdown of self-incompatibility in the examples quoted above (1) and in *S. chacoense*, occurs when the plants have reached their physiological maturity and setting in of senescence. It is probable that the physiological age of the plant together with the environmental factors like photoperiod and temperature[2-5] have a direct control over the operation of the self-incompatibility mechanism.

Biochemical[6,8] and immunogenetical[7,8] investigations of incompatibility suggest that the S gene acts by producing specific proteins in the pollen and style, each allele giving rise to different specificity. Pandey[9] has shown that peroxidase isoenzymes are involved in the expression of the S alleles which control incompatibility and may be linked with the mechanism of action of S genes. Peroxidase isoenzymes have been shown to be influenced by the environment to which the plant is subjected and on the physiological age of the plant. In *Dianthus*, McCown *et al.*[10,11] have demonstrated the presence or absence of certain isoenzymes including isoperoxidases under different light and temperature conditions. Similarly, Warner and Upadhya[12] had shown a photoperiodic control on certain isoenzymes including isoperoxidases in *Citrus*. It is, therefore, possible that the styler and pollen isoperoxidases linked with the S genes, in *Solanum* species also are influenced by the photoperiod and temperature. Townsend[4], in alsike clover had shown that the self-incompatibility reactions could be changed by subjecting the genotype to either low (21° C) or high (32° C) temperatures, and that the site of change for at least one of the genotypes was the style. In *Solanum chacoense*, this possibility is under study. The longer days (about 14 hrs.) and warmer temperatures (between 15 and 25° C) in May-June are most favourable for the production of S gene product, whereas shorter days (about 10-11 hrs) and cooler temperatures (between 8 to 15° C) are less favourable, so that the S genes are less or ineffective in producing products, like needed isoperoxidases, for the expression of incompatibility. This then results in the breakdown of self-incompatibility to allow self-fertilization. The extent of the breakdown of self-incompatibility depends upon the genetic background of the individual clone in which the S genes are present and upon the extent to which different S genes are influenced by the environment. This contention is supported by the data of Marks[1] and in Table I, on differential degree of self-fertilization in different clones of various species studied.

We are thankful to the Director, Central Potato Research Institute, Simla, for his encouragement and facilities.

Central Potato Res. Inst.,
Simla-1, *June* 30, 1971.

MAHESH D. UPADHYA.
C. L. KHUSHU.

---

* Research conducted under PL 480 Scheme Grant No. FG-In-343.

1. Marks, G. E., *New Phytologist*, **1965**, **64**, **293**.
2. Lewis, D., *Proc. Roy. Soc. Lond.*, Ser. B, **1942**, **131**, **13**.
3. Townsend, C. E., *Crop Sci.*, **1966**, **6**, **409**.
4. —, *Ibid.*, **1968**, **8**, **269**.
5. Imrie, B. C., *Ibid.*, **1971**, **11**, **6**.
6. Linskens, H. F., In *Genetics Today—Proc. Eleventh Intern. Congr. Genet.*, (1963), Pergamon, New York, 1965.
7. Makinen, Y. L. A. and Lewis, D., *Genet. Res. Camb.*, 1962, 3, 352.
8. Nasrallah, M. E., Barber, J. T. and Wallace, D. H., *Heredity*, 1970, 25, 23.
9. Pandey, K. K., *Nature*, 1967, **213**, 669.
10. McCown, B. H., Hall, T. C. and Beck, G. E., *Plant Physiol.*, 1969, **44**, 210.
11. —, — and —, *Amer. J. Bot.*, 1970, **57**, **148**.
12. Warner, R. M. and Upadhya, M. D., *Physiol. Plant.*, **1968**, **21**, **941**.

ABNORMAL POSITION OF SILICA CELLS IN THE CYPERACEAE

EPIDERMAL silica cells, with conical silicified processes on their inner walls, are characteristic of the Cyperaceae (Mehra and Sharma[1], Metcalfe[2]). They are present in the costal regions of epidermis of leaf, stem, scale leaf and rhizome. In transection, each silica cell has one silicified process on its inner wall, which is thickened in the form of a pad directly below the process. A silicified process consists of a hollow, hat-shaped (pointed at the top) body of silica fitted on a lignified, conical projection (with a non-lignified pad) of the cell wall (Mehra and Sharma[1]). Very rarely a silicified process may be situated on the radial wall or on the inside of outer wall of an epidermal cell, but silicified processes have not been reported in the ground tissue.

While working on the anatomy of the Indian Cyperaceae, the authors found silica cells in an abnormal position in the stem of *Carex condensata* Nees collected from Mussoorie, Uttar Pradesh. Following the usual method, pieces of stem of this species, preserved in formaline-acetic acid-alcohol, were embedded in paraffin for microtome sectioning. A few pieces of stem were treated with 20% hydrofluoric acid for

10–15 hours prior to processing for paraffin embedding. Free-hand sections were also cut. Both paraffin embedded and free-hand sections were stained in safranin and fast green, and mounted in Canada balsam. Lignin was tested with phloroglucinol and hydrochloric acid.

In transection of the stem, there is a peripheral photosynthetic region with fibro-vascular girders, and an inner colourless region with vascular bundles scattered in the ground tissue. Besides their normal position in the epidermal cells of the costal regions, silicified processes were observed in connection with one or two vascular bundles of the colourless region. Here the silicified processes occur in the cells of the ground tissue abutting against the bundle sheath on the lateral side of the vascular bundle (Fig. 1). Like the subepidermal fibres, the cells of the bundle sheath are thick-walled and lignified. The structure of the silicified processes is exactly like those found in the epidermal cells—hollow body of silica fitted on a lignified, conical projection of the inner tangential wall of silica cell.

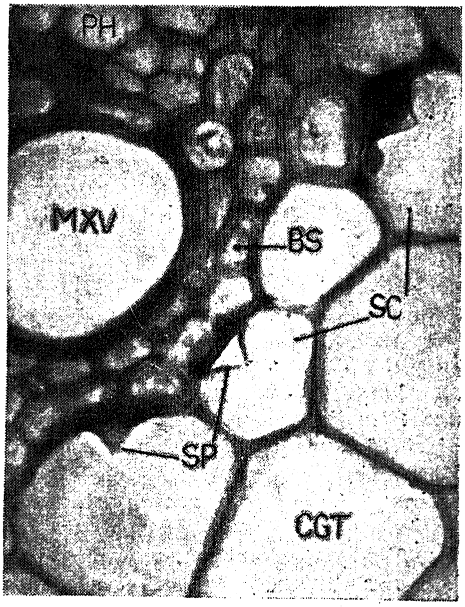


Fig. 1. A portion of colourless region from the transaction of stem of *Carex condensata* showing silicified processes in connection with the bundle sheath, × 1,250. (BS, bundle sheath; CGT, Colourless ground tissue: MXV, Metaxylem vessel; PH, Phloem; SC, Silica cell; SP, Silicified process).

We are thankful to Prof. P. N. Mehra for his keen interest in this work.

Dept. of Botany O. P. Sharma.
and Plant Pathology,
Himachal Pradesh Univ.,
Palampur, H.P.
and
Dept. of Botany, (Miss) Harjit K. Dhingra.
Government College,
Hoshiarpur, Punjab,

June, 23, 1971.

---

1. Mehra, P. N. and Sharma, O. P., "Epidermal silica cells in the Cyperaceae," *Botan. Gaz.*, **1965**, **126**, 53.
2. Metcalfe, C. R., "Anatomy as an aid to classifying the Cyperaceae," *Amer. J. Bot.*, 1969, **56**, 782.

A PALM LEAF FROM THE DECCAN INTERTRAPPEAN SERIES, MOHGAON KALAN (M.P.), INDIA

A well-preserved specimen of a palm leaf was collected by us from Mohgaon Kalan in Chhindwara District, M.P. India. The leaf is incomplete as it shows the middle part of the lamina. The specimen is quite large—it is 50 cm broad and 25 cm long.

Only the middle part of the lamina is preserved which is palmate plicate with a prominent midrib at each fold. Each fold of the lamina is 7 cm broad towards the basal end and becomes broader upto 11 cm towards the apical side. The veins of each fold nearly 150–160 run parallel from the basal end upto the middle and then slightly diverge towards the apical end. Stomata could not be made out. The basal end of the lamina is not preserved, therefore, nothing regarding the attachment of the lamina to the petiole is known (Fig. 1).

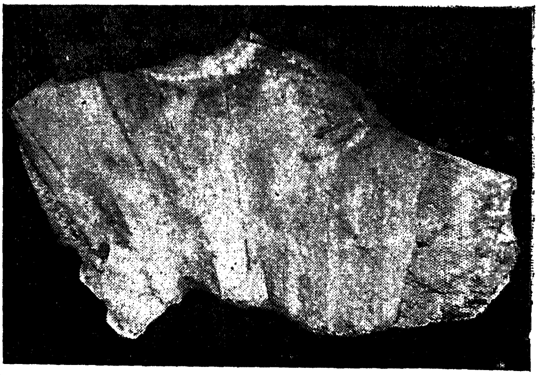


Fig. 1. Photograph showing the leaf impression, × 1/8.

Palmate palms to which our fossil belongs include all sabaloid and borassoid palms. In different genera of sabaloid palms the breadth of each fold of leaf lamina ranges from 1·3 to 3·9 cm. In *Latania*[1] a borassoid type of palm, the breadth of each fold varies from 7·8 to 9·1 cm which is comparable to our specimen (7-11 cm). As the specimen is incomplete, all that can be said regarding its affinities is that it is likely to be the leaf of a borassoid type of palm. Although a large number of palm stems have been described from the Deccan Intertrappean series[2] as far as the authors are aware, this is probably the first record of a palm leaf from this series.

Dept. of Botany, B. S. TRIVEDI.
Lucknow University, R. CHANDRA.
Lucknow, *May* 24, 1971.

---

1. Blatter, *Palms of British India and Ceylon.*
2. Sahni, B , *Revisions of Indian Fossil Plants: Part III—Monocotyledons.*

TETRAPLOID CHROMOSOME NUMBER IN THE GENUS *SPILANTHES* LINN.

COVAS and Schnack[2] have reported the chromosome number, $2n = 26$, in *Spilanthes decumbens,* L. However, the available literature shows no record of the chromosome number in another species *acmella* of the same genus. This species includes annuals which are erect or ascending with hairy stems and branches, and leaves which are opposite, ovate, acute, serrate and petiolate; heads are $\frac{1}{4}''$ to $\frac{3}{4}''$ long and solitary with long peduncles. Ray florets are generally absent. These annuals are cultivated for ornamental and medicinal purposes. The heads when chewed give hot burning taste and cause profuse salivation. They are generally chewed for getting relief from cough (Cooke[1]).

This species was collected from Maharajbagh, Nagpur, in the year 1968 and was grown in pots in the Botany Section of this College. It was studied cytologically for chromosome number and behaviour. For meiotic and pollen grain studies 1% aceto-carmine technique was used. The chromosome count was made at diakinesis and metaphase I of meiosis.

Earlier stages of prophase I could not be studied because of comparatively large chromosome number in a small-sized pollen mother cell. At diakinesis 26 bivalents could be clearly counted (Fig. 1), out of which two bivalents were seen attached to the nucleolus, thereby pointing to the tetraploid nature of the species. The association of chromosomes was purely in the form of bivalents. No quadrivalent, trivalent and univalent were noticed at diakinesis. Metaphase I also showed 26 bivalents. At anaphase I 26 chromosomes were found at each pole. Metaphase II and anaphase II were found to be regular thereby leading to the formation of fertile pollen grains to the extent of 99%.

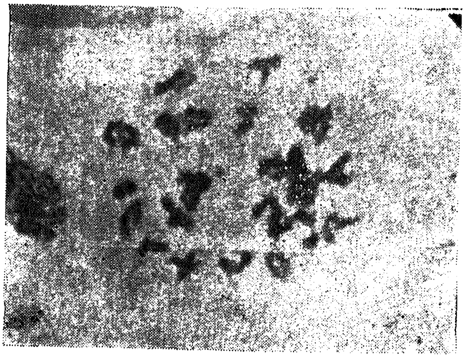


FIG. 1. Shows 26 bivalents at diakinesis, × 1.000.

From the fact that no cytological absormalities were found at different stages of meiosis I and II and the formation of fertile microspores, the allotetraploid nature of the species is confirmed.

Botany Section, M. N. NARKHEDE.
Agric. College, B. A. PHADNIS.
Nagpur (M.S.), *June* 11, 1971.

---

1. Cooke, T., *Flora of Bombay*, Govt. of India. 1958 2, 99.
2. Covas, G. and Schnack, B., *Rev. Argent, Agron.*. 1947, **14**, 224.

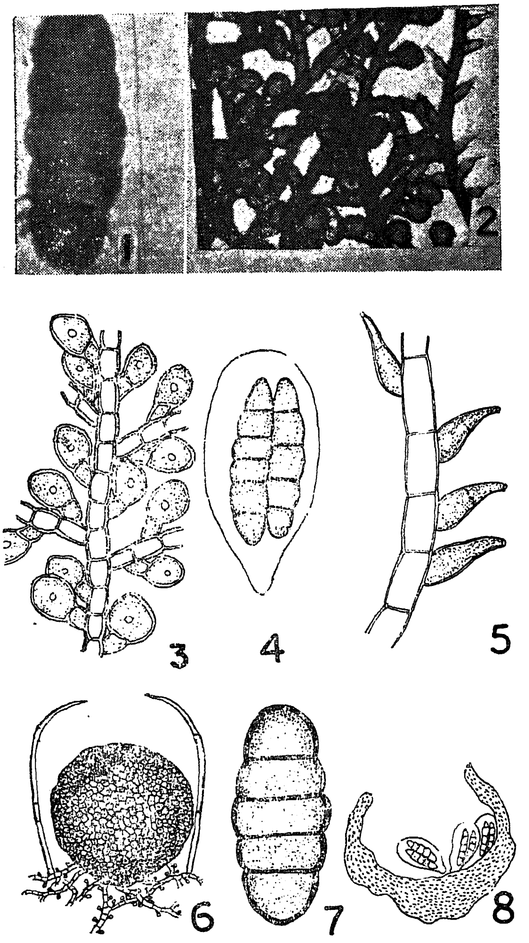
A NOTE ON *MELIOLA JUTTINGII* HANSF. ON *PANDANUS ODORATISSIMUS* L. FROM KERALA

A sooty mould was collected by the author from Tellicherry, S. India, during January 1970 on the leaves of *Pandanus odoratissimus* growing near a stream. Further critical examination showed this to be a species of the genus *Meliola,* viz., *M. juttingii* Hansf[2].

The epiphyllous colonies form dense black spots more or less completely covering the leaves. The dark superficial mycelium is branched and septate (Fig. 2). The length and diameter of the mycelial cells are almost uniform throughout—21–23 $\mu \times$ 12–13 μ. Branching is mostly alternate, very rarely opposite.

Hyphopodia are of two types: capitate and mucronate. The capitate hyphopodia (Figs. 2 and 3) are two-celled and arise laterally. They are mostly alternate, very rarely opposite. The terminal cell is sub-globose, 36–37 $\mu \times$ 25–26 μ, and slightly bent forwards. Almost every cell of the mycelium gives rise to either a hyphopodium or a branch. Capitate hyphopodia are found evenly distributed throughout the colony and are "antrorse".

The mucronate hyphopodia (Figs. 2 and 5) measure 33–39 μ × 12–13 μ and unlike the capitate ones, are limited to certain special branches. Such branches are generally found towards the periphery of the colony. They are alternate or opposite and ampulliform. These flask-shaped structures have a distinct 'body' and a terminal 'neck'. The neck is slightly lateral.



FIGS. 1–8. *Meliola juttingii*. Hansf. on *Pandanus odoratissimus*. Fig. 1. Ascospore, × 435. Fig. 2. Branched septate mycelium with capitate and mucronate hyphopodia, × 200. Fig. 3. Capitate hyphopodia, × 250. Fig. 4. Ascus with 2 ascospores, × 435. Fig. 5. Mucronate hyphopodia, × 435. Fig. 6. Perithecium surrounded by mycelial setae, × 75. Fig. 7. Ascospore, × 435. Fig. 8. Perithecium with few asci and ascospores, × 75.

Mycelial setae, which are one of the distinguishing features of *Meliola*, are present in this species also. They measure 246 μ × 12 μ. They are black in colour, like the perithecia, and are found to occur in groups around the base of each perithecium, arising from the subperithecial subiculum. They do not arise from the perithecia. The setae are septate, simple and bent at their apices (Fig. 6).

The perithecia are dark globose structures, which measure about 258 μ in diameter and are found aggregated into a central group in the colony. The wall of the perithecium is made up of 3–4 layers of cells. At the apex there is a small round pore. The mature perithecium rests on a thin subiculum (base) closely adherent to the cuticle of the host (Fig. 6), the several asci forming a loose basal group within the perithecium (Fig. 8). Each ascus has two ascospores (Fig. 4). In the mature perithecium the asci undergo autolysis and the ascospores lie loose in a mucilaginous matrix.

There are normally 8–16 asci in each perithecium. The ascospores are uniform in size and septation and are 56–69 μ long and 21–28 μ broad. They are 4 septate, rarely 5 septate and are constricted at the region of the septa (Figs. 1 and 7). They have a smooth surface. The spores have dark walls and have the septa also of the same thickness.

Meliola juttingii does not appear to have been recorded from India so far[1,3-7].

The author is grateful to Dr. M. S. Balakrishnan and to Dr. S. D. Patil for helpful suggestions and encouragement.

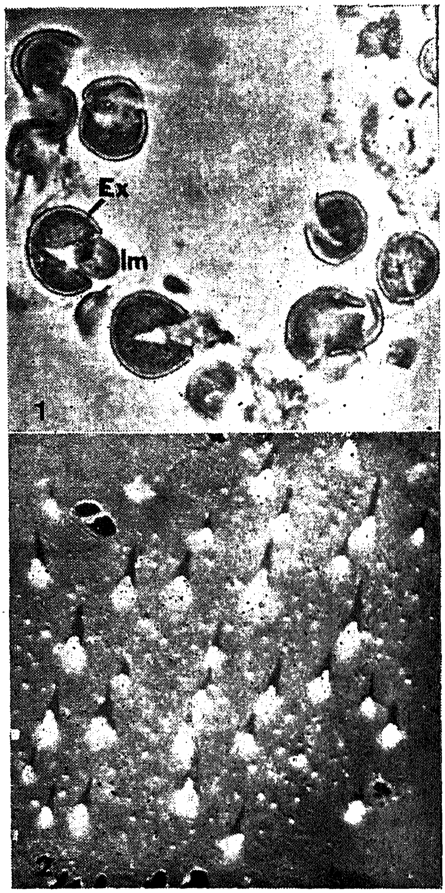
Dept. of Botany, LIZZIE N. NAIR.
University of Poona, *June* 25, 1971.

---

1. Butler, E. J. and Bisby, G. R., "Fungi of India," In *Coun. of Agri. Research, India*, *Sci. Mono.* (1930), Revd. by Vasudeva, R. S., 1960.
2. Hansford, G. C., "The Meliolineae," *Sydowia Beih.*, 1961, 2.
3. Ramakrishnan, K. and Subramaniam, C. V., *The Fungi of India*, Second Supplement, 1952.
4. Rangaswamy, G., Sheshadri, S. and Lucy, K. A. Channamma., *Fungi of South India*, Univ. of Agri. Sciences, Bangalore, Hebbal, 1970.
5. Tandon, R. N. and Sudhir Chandra, *Supplement to the List of Indian Fungi*, Univ. of Allahabad (Bot. Section), 1957–62, **25**, 963.
6. Tilak, S. T. and Ramachandra Rao, *Fungi of India*, Supplement 2 (1962–67), 1969.
7. Vasudeva, R. S., *Fungi of India*, Supplement 1, Agri. Res., New Delhi, 1966.

ELECTRON MICROSCOPY OF TELIOSPORES OF *MELANOPSICHIUM ELEUSINIS* (RAGI SMUT)

THE smut of finger millet (Ragi) was first identified as *Ustilago eleusinis* by Kulkarni[1]. Later, Mundkur and Thirumalachar[2] renamed it as *Melanopsichium eleusinis* and described the spores as globose to subglobose with a densely pitted epispore. Zundel[3] who retained the earlier name stated that the spores are olivaceous brown and pitted with the edge of the spore roughened.



FIGS. 1–2. Fig. 1. Showing ruptured teliospores with exosporium (Ex) and released inner mass (Im), × 670. Fig. 2. Electron micrograph of spore replica showing large-sized conical pointed spines and minute papillate outgrowths, × 12,500.

Spore material of *M. eleusinis* on *Eleusine coracana* Gaertn. was obtained from Agricultural University, Bangalore, through the courtesy of Dr. H. R. R. Reddy during 1963.

For optical microscopic studies, the spores were processed in accordance with the method of Graham[4]. By this method it is easy to separate the spore wall layers.

Spore replicas for electron microscopy were prepared by adopting gum-formvar technique (Hess and Schantz[5], Khanna, *et al.*[6]). In the light microscope, spores are spherical to subspherical and dark brown (Fig. 1). They measure 8·0–12·0 μ with an average of 10·5 μ in diameter. The outer layer or the exosporium is highly pigmented and bears projections. The spores on rupture release the inner contents including the protoplast. The released inner mass is spherical to subspherical, hyaline and measures 6·4–9·0 μ (Mean, 8·0 μ) in diameter.

Figure 2 shows surface replica of a part of spore on gum-formvar. The surface is densely echinulate and shows two types of outgrowths. The large-sized conical projections are sharply pointed. They measure 150 ± 25 nm in height and are 180 ± 26 nm broad at the base. In addition, numerous small outgrowths designated as 'spinulae' or 'papillae' are also present. These are 20 ± 5 nm in height and 35 ± 5 nm broad at the base.

An important and interesting feature of the spores studied here is the occurrence of submicroscopic 'spinulae' which are small papilliate outgrowths interspersed among the regular large sized projections on the exosporium. The presence of two kinds of projections has also been observed in teliospores of *Sphacelotheca reiliana* (Khanna and Payak, Unpublished). This study has shown that the spores in *Melanopsichium eleusinis* are echinulate and not pitted as shown by earlier workers.

We are grateful to Dr. S. P. Raychaudhuri for his interest in this work.

Division of Mycology and
Plant Pathology,
Indian Agricultural Research
Institute,
New Delhi-12, *May* 21, 1971.

ASHA KHANNA.
M. M. PAYAK.

---

1. Kulkarni, G. S., *Ann. Appl. Biol.*, 1922, **9**, 184.
2. Mundkur, B. B. and Thirumalachar, M. J., *Mycological Paper No. 16*, 1946.
3. Zundel, G. L., *The Ustilaginales of the World*, Pennsylvania State University, 1953, **11**, 410.
4. Graham, S. O., *Mycologia*, 1960, **52**, 97.
5. Hess, G. E. and Schantz, E. J., *Science*, 1956, **123**, 983.
6. Khanna, A., Payak, M. M. and Mehta, S. C., *Mycologia*, 1966, **68**, 562.

REVIEWS AND NOTICES OF BOOKS

Shock: Biochemical, Pharmacologial and Clinical Aspects. Edited by A. Bertelli and N. Back. (Plenum Press, New York), 1970. Pp. xiii + 353. Price $ 19.50.

This volume is the outcome of the proceedings of the International Symposium on Shock held at Como, Italy, during October 10–11, 1969. The multidisciplinary approach is very evident in the presentation of the topics which are discussed under the broad divisions of pathogenesis of shock, biochemical pathology of shock, pharmacology of shock and the clinical and therapeutic aspects of shock.

The section on pathogenesis of shock attempts to analyse the various physiological alterations seen under diverse experimental conditions of shock. In studies related to haemorrhagic shock, the role of splanchnic adrenergic vasoconstriction in the development of irreversibility, the effects of such shock on canine forelimb transcapillary fluid fluxes and segmental vascular resistances and the extent and type of renal failure seen have been presented. Role of reticuloendothelial system in endotoxin shock, behaviour of histidine decarboxylase in various forms of shock, the role of coagulation-fibrinolysis in the pathophysiology of shock, complement and shock, the circulatory functions in the early post-operative period after pulmonary surgery and the proposed mechanism for the ameliorative effects of corticosteroids in shock are the other topics discussed in this section.

The section on biochemical pathology of shock deals with the participation of the kinin-system in different kinds of shock, the generation of kinins in the circulation of the dog during hypotension due to blood loss, pharmacological and biochemical aspects of cystamine—and cystamine induced shock and the effect of varying blood sugar level in anaphylactic shock. Continuous registration of the oxygen uptake is shown to constitute the most valuable parameter for comparative shock studies.

Influence of blood pH on peripheral vascular tone, the possible role of proteases and vaso-active polypeptides, and the role of lysosomal enzymes in shock, and drug therapy in shock are the topics presented in the section on 'Pharmacology of Shock'.

Problems of clinical research in shock and the physician's responsibility to establish not only the proper qualitative therapy but also to determine the optimal dose of each agent needed to achieve the desired net cardiovascular effect with particular patient have been very well brought out in the section dealing with clinical and therapeutic aspects of shock.

Treatment of shock with Trasylol a proteinase inhibitor, β-adrenetrgic blockade with propranolol in hyperdynamic shock, the application of Poly-N^5-(2-hydroxy ethyl)-L-glutamine a new plasma expander in conditions of shock and Dihydroergotamine in the treatment of orthostatic shock present the recent trends in the management and therapy of various types of shock.

M. SIRSI.

Enzyme Synthesis and Degradation in Mammalian Systems. Edited by M. Rechcigl, Jr. (S. Karger AG, Medical and Scientific publishers, Arnold-Bocklin-Strasse-25, CH-4,000 Basel 11, Switzerland), 1971. Pp. xvi + 477. 73 Figures, 23 Tables. Price SFr 90·00; £ 9.50; DM 90.00.

Researches on enzymes and enzyme activity in living organisms have assumed great importance in recent years following new knowledge on the subject based on findings from employing new techniques of investigation. This treatise provides a comprehensive review of the present knowledge of the various factors that control enzyme activity as well as the regulatory mechanisms involved in enzyme synthesis and degradation, with special emphasis on the mammalian systems. Seventeen authors, each one an active worker and a leading authority on the particular topic he has written, have contributed to this volume.

The topics covered include the genetics of enzyme realization, the control of enzyme activity in mammals in early development and in old age, control of enzyme activity by glucocorticoids and nutritional factors, regulation of protein activity, enzyme induction and repression, translational regulation of enzyme levels in liver, intracellular protein turnover and the roles of synthesis and degradation in regulation of enzyme levels, rhythms in enzymes that metabolize aromatic amino-acids, factors affecting the activity, tissue distribution, synthesis and degradation of isozymes, and finally, synthesis and degradation of proteins in relation to cellular structure.

The authors in their treatment of the topics concerned have provided not only a review and latest information but new aspects of the subject which will stimulate interest in the reader, be he a graduate student or an advance researcher. The book will be of assistance to workers on enzyme activity in different disciplines such as biologists, biochemists, zoologists, pathologists, geneticists, pharmacologists, and nutritionists.

A thorough subject index of over forty pages and a glossary will be of special value to beginning students, while the numerous literature references at the end of each section will help the resarch workers. A. S. G.

S.P.I.E. Seminar Proceedings (Published by the Society of Photo-optical Instrumentation Engineers, P.O. Box 288, Redondo Beach, California 90277, U.S.A.).

Vol. 10—Space-Optics, Pp. 155; Vol. 20—Developments in Laser Technology, Pp. 184; Vol. 21—Fiber Optics—Applications and Technology, Pp. 148.

These volumes copyrighted by the Society of Photo-optical Instrumentation Engineers (SPIE) contain the proceedings of Seminars-in-Depth held under the auspices of the SPIE and cosponsored by other closely connected organisations at different centres and at different times. They contain the latest in the state of art in instrumentation and technology concerned with the topic of the seminar.

The Space-Optics seminar was held on 24th and 25th September 1969 at Santa Barbara, California, cosponsored by the U.S. Air Force Office of Aerospace Research and ESSA National Environmental Satellite Center. It contains thirteen papers relating to earth photography from space, optical instrumentation and planetary photography.

The seminar on Laser Technology was cosponsored by the University of Rochester Institute of Optics, and was held at Rochester, New York, on November 11–18, 1969. It contains ten papers relating to laser sources, and nine papers on laser applications.

The seminar in depth conducted by the Fiber Optics Working Group was held in Ballas, Texas, on January 28–29, 1970. The fifteen papers of the seminar are grouped under Standards and specifications (5), Applications (6) and Materials (4).

To draw attention on the nature of contents and the value of these publications we quote the following from the introduction to Vol. 20. To arrange the seminars-in-depth the procedure followed was: "Firstly, we determined the areas of prime interest in Laser Technology. Secondly we invited leaders in these areas to survey the state-of-the-art. Thirdly and equally importantly we allowed each of the invited speakers to have sufficient time to develop his subject. Finally we selected the best of the contributed papers to make up a session of short communications which had relevance to the main presentations.

Our aim in putting together a published proceedings was of course, to document the meeting but more importantly, we hope that this volume will reflect the state-of-the-art as of late 1969 and hence provide a bench mark in the literature and a starting point for reading the literature from this point onwards".

Annual Review of Entomology (Vol. 16). (Annual Reviews Inc., 4139 El Camino Way, Palo Alto, California 94306, U.S.A.), 1971. Pp. vii + 486. Price U.S.A., $ 10.00, Foreign $ 10.50.

These annual publications brought out by the Annual Reviews Inc., provide updated summaries of the state of knowledge on the subject concerned, and remain important reference sources for active research workers in the particular field of study. This year's volume on Entomology contains sixteen review articles, some of which are on topics which appear for the first time, while others are continuation of topics reviewed earlier but which bring the material up-to-date and refer to work done within the last few years. Special mention may be made to the following articles of general interest in this volume. Arthropod silks by K. M. Rudall and W. Kenchington; Sorptive Dusts for Pest Control by Walter Ebeling; Effect of Defoliation by Forest Insects by H. M. Kulman; Pesticides and Wildlife by O. B. Cope and Indirect Sperm Transfer by Soil Arthropods by F. Schaller.

The other articles in this volume are: Blood-sucking Behaviour of Terrestial Arthropods by B. Hocking; Insect Cell and Tissue Culture by M. A. Brooks and T. J. Kurtti; Steroid Metaboblism in Insects by W. E. Poblins, J. N. Kaplanis, J. A. Savoboda and M. J. Thompson;

Bioluminescent Communication in Insects by J. L. Lloyd; Host Specificity for Biological Control of Weeds by H. Zwolfer and P. Harris; Bionomics of Leafhoppers by D. M. Delong, of Chironomids by D. R. Oliver, of Autogenous Mosquitoes by A. Spielman; Bioecology of Collembola and Acarina by J. W. Butcher, R. Snider and R. J. Snider; Regulation of Feeding by A. Gelperin; and Comparative Morphology of Insect Genitalia by G. C. E. Scudder. A. S. G.

Block Polymers. Edited by S. L. Aggarwal (Plenum Press, 114, Fifth Avenue, New York, N.Y. 10011), 1971, Pp. 339. Price $ 16.00.

A growing field of research in polymer science is the preparation of polymers of controlled structure. Catalysts and polymerization methods to control the stereo and geometric isomerism of the monomer units have been major developments during the last decade. The synthesis of block polymers, in which the sequence length of the comonomer units can be controlled opens out wide possibilities in the science and technology of polymers.

The twenty-three papers contained in this volume cover primarily the proceedings of the symposium on block polymers held in September 1969 in New York City, sponsored by the Polymer Chemistry Division of the American Chemical Society. They provide collective information on the developments in the subject and should stimulate further systematic studies on the applications of block polymers. A. S. G.

ANNOUNCEMENTS

Colloquium on Micropalaeontology and Stratigraphy, 8–10 October, 1971 (Sponsored by the Committee for the Celebration of the 75th Birthday of Prof. L. Rama Rao)

The Colloquium is organised by the Committee as part of the celebrations of the 75th birthday of Prof. L. Rama Rao. The participants are drawn from the Geological Survey of India, Oil and Natural Gas Commission and all the University Departments where active work in the field of micropalaeontology and stratigraphy is going on.

The Colloquium will cover all groups of microfossils and all eras of the geological time. It will take place at the Institution of Engineers (India), 3, Vidhana Veedhi, Bangalore-1.

On the first day 8-10-1971 there will be sessions on Precambrian-Lower Palaeozoic, Upper Palaeozoic, Mesozoic and Tertiary (Paleogene). On the second day 9-10-1971 there will be morning sessions on Tertiary (Neogene), and Quaternary. These will be followed in the afternoon by Review Session and Plenary Session.

On 10-10-1971 there will be an excursion to Precambrian fossil localities—G. R. Halli and Dodguni (Chitraldurg Schist Belt).

Seminar on "Scientific, Technological and Legal Aspects of the Indian Continental Shelf"

The Indian Geophysical Union and the Indian National Committee of Oceanic Research are jointly sponsoring a Seminar on "Scientific, Technological and Legal Aspects of the Indian Continental Shelf" at Panjim (Goa) from 11th to 13th November 1971.

There will be four technical sessions: (*i*) Geological, Geophysical and Economic Aspects; (*ii*) Living Resources; (*iii*) Physical and Chemical Features; (*iv*) Legal Aspects.

Participants are requested to contact the Secretary, Indian Geophysical Union, Hyderabad-7, for further information.

Award of Research Degrees

Osmania University, Hyderabad, has awarded the Ph.D. degree in Physics to Shri K. Satyanarayana Murthy.

The M.S. University of Baroda has awarded the Ph.D. degree in Zoology to Shri K. C. George.

Sri Venkateswara University, Tirupati, has awarded the Ph.D. degree in Zoology to Shri A. Subbarami Reddy.

Books Received

Specific Heat—Non-Metallic Liquids and Gases. (Vol. 6). By Y. S. Touloukian, T. Makita (Plenum Pub. Corpn., New York 10011), 1970. Pp. xviii + 312. Price $ 40.00.

Thermal Radiative Properties—Metallic Elements and Alloys. (Vol. 7). By Y. S. Touloukian, D. P. Dewitt (Plenum Pub. Corporation, New York 10011), 1970. Pp. xxix + 1539. Price $ 100.00.

Higher Cortical Functions in Man. By A. R. Luria (Plenum Pub. Corporation, New York 10011, N.Y.), 1970. Pp. xvi + 513. Price $ 17.50.

Organic Semiconductors and Biopolymers. By L. I. Boguslavskii, A. V. Vannikov (Plenum Pub. Corpn., New York), 1970. Pp. xii + 221. Price $ 18.50.

Origin and Mechanisms of Hallucinations. Edited by Wolfram Keup (Plenum Pub. Corpn., New York 10011), 1971. Pp. xxi + 479. Price $ 18.50.

3053-71. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.

AGRICULTURE, SCIENCE AND HUMANITY*

DR. B. P. PAL

Director-General, Indian Council of Agricultural Research, New Delhi

I am deeply conscious of the high honour which has been bestowed upon me by the Trustees of the Raman Research Institute in their invitation to me to deliver the Gandhi Memorial Lecture. I still do not feel that I am worthy of the task which has been assigned to me. But I have accepted in all humility because I felt that by doing so I could render my personal homage to the greatest scientist India has produced, Professor Sir C. V. Raman. My talk is in three parts; in the first I will discuss agriculture and food, in the second I will refer briefly to the role of science, and finally, in the third section I will consider some problems of humanity and how science and education can help in solving them.

AGRICULTURE AND FOOD

Green chlorophyll came before red blood; plants preceded animals on this earth of ours and the green leaf governs the economy of nature. The early history of man is shrouded in the mists of time. But the evolutionary record clearly delineates man's kinship with the animal world and there is no reason to doubt that man and the great apes evolved from a common stock. Henry Bailey Stevens has speculated that man's ancestors, like the great apes, lived in the trees and subsisted on a diet of fruits, nuts and tender leaves. But when prehistoric man descended to the ground he had to become a hunter to gain his daily food.

There was a very long period of time before man by a slow process of domestication of plants and animals laid the foundations of a settled agriculture, so essential for the development of civilization. But the early history of agriculture, like that of man himself, is a matter of conjecture. Archaeologists, anthropologists and others have studied the remains that are found at the ancient sites uncovered by excavations and propounded theories as to what must have been the conditions of human life in those bygone eras. Even about that well-loved flower, the rose, Walter de la Mare has said:

'Oh! no man knows
  Through what wild centuries
    Roves back the rose.'

In the case of most of our crop plants too, no one knows when they were first cultivated; quite often even the immediate ancestors of these types have disappeared, leaving scope for the writing of many doctoral theses on their supposed origins.

It is truly astonishing that early man was able to do such a remarkable job of plant improvement. As Edgar Anderson has pointed out, modern man, in the 5,000 years of recorded history, has not been able to add a single major crop to his list of domesticates! Thus in the New World, maize, sunflower, cucurbits including the gourd, two species of tobacco, three species of Phaseolus, the groundnut, the amaranth and the quinoa had already become cultivated plants before the dawn of recorded history. Similarly, in the Old World, wheat, rice and a great many other economic plants including fruits and vegetables had been developed. It appears that, in the beginning, the tendency was to make multiple uses of plants rather than cultivate them for a single purpose as is often the case in our modern massproduction agriculture.

---

* Gandhi Memorial Lecture delivered at the Raman Research Institute, Bangalore, on October 2, 1971.

Thanks to the outstanding contributions of that great Russian botanist, N. I. Vavilov, the importance of collecting and preserving as wide a range of germplasm as possible of economic plants and their wild allies has come to be recognized. Vavilov's life work also indicated that there were some areas in the world in which as a result of favourable conditions, species and varieties of certain economic plants were found in unusually amazing abundance. These he regarded as centres of origin of our cultivated plants. There has been some tendency recently to question whether these were really the centres of origin or rather the centres of survival of genetically important variations. But whichever view is taken, there is no doubt that these natural gene pools are very important for the immediate and future work of the plant breeders, and everything possible must be done to collect and conserve them before valuable genes are lost for ever.

As every one knows, human beings as well as animals require food in order to live. While plants because of their possession of chlorophyll can, utilizing the energy of sunlight, create their own food, all animals and man either live on plants or on animals which again, in their turn, live on plants. To be in good health the human body requires to be in a state of efficiency, *i.e.*, not in mere passive existence but with the capability to resist disease and to meet other calls upon its energy. Food is a primary necessity and as the Japanese saying points out:

> 'Even Fuji is without beauty to one hungry and cold.'

Mahatma Gandhi referred to the same fact in the following unforgettable words: "I may as well place before the dog over there the message of God as before those hungry millions who have no lustre in their eyes ...... how am I to talk of God to the millions who have to go without two meals a day? To them God can only appear as bread and butter." In another significant sentence, on another occasion, he said: "To a people famishing and idle, the only acceptable form in which God can dare appear is work and promise of food as wages."

One of the great problems of the present world is that of food supply for the population of the world which is increasing at a terrifying pace. While the developed countries are largely characterised by large farms and adequate resources with which they are able to produce enough food of the different kinds required, in the densely-peopled under-developed countries, there is a continuous struggle to find the means of subsistence for huge populations. In most parts of tropical and sub-tropical Asia the average farmer has a small holding, usually about two hectares, and from this little piece of land without any other resources he has to maintain a family of 8 or 9 or even more persons Unless we can find the means of feeding the millions of human beings who already inhabit this earth, talk of other things becomes almost meaningless. Though one recognizes that man does not subsist by bread alone, yet unless the bread is there he cannot exist to partake of the finer things of life. It is one of the tragic paradoxes of our time that while in some countries there is so much surplus agricultural production that food or other useful materials are burnt or thrown away to maintain a high level of prices, or farmers are subsidised not to produce more agricultural products; in large parts of the world there is the most grimly severe under-nutrition and malnutrition. In spite of the fact that man is heir to so many centuries of civilization and so many great religions have preached the brotherhood of man and other qualities, yet those who have the opulence permit the unfortunate people of the poorer countries to starve. While there is money and extraordinary scientific resources to permit space explorations, such resources and such intensive scientific endeavours have not been available to remove the misery of the world.

Agriculture therefore has, as never before, a role of the utmost significance for the welfare of humanity. In the past, in many countries like ours, it occupied a lowly place in the scheme of things. Even among the sciences, agricultural science was considered to be a plebeian sort of science. Its votaries were not as well paid as the others and suffered from various disadvantages. Fortunately, in very recent years, some changes for the better have taken place. In this country there has been some re-organization of agricultural research and education, and already this has yielded results which have enabled us for the present to ward off the threat of famine and given us the confidence to face the future.

We must, however, take serious note of the fact that even with the best of efforts, after a while there will not be sufficient food unless the rate of population increase is greatly slowed down, especially in the developing countries where the problem is most acute. The urge to reproduce is one of the fundamental characteristics of all living matter and in some forms of life the rate of multiplication is fantastic. According to Dr. S. Pradhan "It has been calculated that the progeny of a single moth can cover the entire dry surface of the earth to a depth of 80 feet within a period of one year in case all the progeny is allowed to live their normal life. This calculation is on the assumption that a moth lays just 200 eggs and completes the life-history in one month. Both these assumptions are quite normal for a large number of insect species while there are species of insect in which thousands of eggs are laid per female". Compared to this, the reproductive capacity of the human race is quite modest but human beings require much more food per individual and they also have other requirements. Already in many countries we have reached or even somewhat exceeded the safe limits for bringing land under the plough. If we encroach further upon our precious forests and pasture lands, this may lead to dolorous results, changing even the climate of the country for the worse.

The developing countries have many handicaps to overcome. The soil in many of them is highly eroded and exhausted in its content of major nutrients due to centuries of exploitation. There are many other problems also. But there is also tremendous potentiality. In a masterly summary, Dr. M. S. Swaminathan, in a paper prepared for a conference dealing with the role of nuclear techniques in agricultural research in developing countries refers to "certain unusual possibilities awaiting exploitation" which are now in sight. These have opened up entirely new vistas for increasing the productivity of irrigated agriculture in the tropics and sub-tropics, which are endowed with abundant sunlight throughout the year, through the developments of scientific multiple—and relay —cropping systems. Then through the introduction of genetic factors for photo- and thermo-insensitivity most crop plants can be made to flower and fruit within a specific period thereby eliminating or reducing their dependence on seasons and making the introduction of the concept of "productivity per day" possible. Further, considerable advances in water technology and water harvesting procedures have taken place with the result that the productivity per unit of water can be considerably enhanced and dry land farming made more remunerative. Again, developments in fertilizer technology and pest control procedures coupled with the concept of appropriate plant types or architecture have changed many old notions on the genetic ceilings to yield. This in turn has opened up new prospects for re-structuring cropping systems so as to maximise the income from small holdings. Then again, advances in post-harvest technology have made income from agriculture (including horticulture and animal husbandry) more secure and stable. Finally, and most importantly, experience from developing countries which have introduced a synergistic package of new practices in areas where agriculture had remained stagnant for a long time, has clearly revealed that the new technology can serve as a catalyst bringing about rapid change in the outlook of the farming community, provided the technology offers hope for making a substantial jump in yield and income. All this fills us with hope, but as that great wheat breeder and humanist, Dr. Norman Borlaug has warned, "there is no time to relax".

A modern society requires that there should be, besides food, roads, railways, air-fields, industrial complexes and the like; there also has to be provision for schools, hospitals and other necessary amenities. But if we plan with sagacity, using science both to increase the productivity of agriculture and to slow down the birthrate of the human race, the problems of food supply and raw materials for trade and industry can be assured.

THE ROLE OF SCIENCE

Science is essentially a quest for truth. Modern science has developed to such a great extent, and at such a tremendous pace during the past few decades, that its results permeate every segment of our lives. For instance, the great advances in locomotion and transport have made the world much smaller, bringing the peoples of various countries closer together. The power of electricity can now be used in so many wonderful ways. But one could go on listing the great achievements of science and one would end up with a most imposing statement which could cover several hundred pages. According to the old Greek legend, Prometheus stole fire from heaven and brought it down to earth for the benefit of mankind, for which he was punished in a terrible way by Zeus. Science, like a modern Prometheus, has brought hundreds of things within the reach of man, helping many to live a life more complete with amenities and comforts than was possible before. Above all it has made it possible for leisure to be given to men. As long as man was dragged down by the drudgery of eking out his daily existence without the help of scientific tools, he had little time for anything else and leisure is necessary for man to think and to concern himself with the higher things of life. But even today there are millions of our fellow beings who do not have leisure. In fact, as pointed out by Bertrand Russell, "the idea that the poor should have leisure has always been shocking to the rich"! We have to see, with so much development in science, that all human beings have the requisite amount of leisure. One does not, of course, advocate all leisure and no work: lives which are devoted only to pursuits of pleasure and not balanced by the required quantum of work would not be really lives of contentment and fulfilment.

I have referred just now to the need for men to have work to do, in addition to leisure. In fact those who have tried to analyse that intangible and elusive state of mind called happiness, have usually come to the conclusion that work which one likes is a necessary ingredient for achieving it. It may not be possible for all persons to have the type of work they would most like, but undoubtedly there must be provision for everyone to have employment which will enable him to earn the necessary income to buy the daily requirements of himself and his family. The problem of unemployment already looms before us menacingly; in the future it may acquire even larger proportions. It, therefore, behoves us to use all our knowledge and our scientific capability to take steps to deal with this problem and provide employment to the millions of our fellow men before the problem gets out of hand.

In this country between 70 and 80% of the population lives directly or indirectly by agriculture. It appears that, unlike what has happened in many advanced countries where the farming community has dwindled to a very low figure, in India this is not likely to happen on a large-scale in the next couple of decades at any rate. The problem therefore is one of finding employment especially for the members of the farming families. It would be tragic if there is a large-scale exodus from the countryside to the cities which are already over-crowded. The remedy seems to lie in a phased but rapid development of agro-industries, especially the small and medium ones, in the rural areas, taking care of course to see that problems of pollution, etc., are foreseen and avoided, and that the natural tranquillity and beauty of the countryside is preserved as much as possible. It is only industry which can give employment to very large numbers of people but it is not necessary that all industry must be located in the big cities. With the experience which is now available, and keeping in mind the agricultural transformation which has begun to take place, there seems to be a great opportunity for setting up a number of agro-industries specially selected for the needs of the various regions.

While I have referred so far to the many benefits resulting from science, there are also many undesirable effects from the wrong use of science. Everyone is now aware of the large-scale pollution of the atmosphere and the waters of our rivers and lakes which has come as the result of large-scale industrial enterprises, the increasing use of deadly chemicals as pesticides, etc. In everyday life also, one is made aware of how painful the devices which science has given us can be. For instance we are subjected to so much noise—trains hurtle past, jet planes screech in the sky and transistor radios and loudspeakers violate the ether everywhere. Some people even seem to think that prayers cannot reach God unless they are rendered with the use of loudspeakers at full volume.

But if properly used, science is an invaluable tool not only for helping us to achieve greater agricultural production but also to help us to do our work with the minimum of drudgery; it can also give us many ways in which life can be made richer, fuller, more rewarding.

THE PROBLEMS OF HUMANITY

This earth of ours, at her fairest, is beautiful, wonderful. Witness the serenity of the deep cobalt blue firmament on a fine day. And the shapes and forms of the everchanging clouds—dazzling white cumulus clouds piled high, one upon another, or the fleecy, softly moving, cirrus types. What wonderful colours are displayed in a sunset: here, rose and amethyst melt into gold and orange, while there, mauve and lilac tints change and transform themselves into yet other indescribable hues, and the deep blue of the upper heaven softens into caerulean and lemon as it approaches the horizon.

Or, behold the spiritually uplifting world of the Himalayas; mountain range succeeds mountain range until the eternally snowclad sentinels of the north of our land are reached. Who has not felt elevated, far above the affairs of the mundane world, in this realm of snow-capped peaks, fair valleys and forests of whispering pines and deodars? Then there is the wonder of flowers whose colours held such a deep fascination for Professor Raman; the wonder of birds and butterflies, of rainbows, of palm-fringed golden beaches and starlit nights. And man himself has sometimes built marvellous temples and churches and mosques tapering into the sky as though trying to reach the realm of God, while in their interiors men and women have assembled to renew their faith. And finally, there is the miracle of human love.

But there is the other side of life. Nature can be terrible in some of her moods. There can be volcanic eruptions, earthquakes, floods, typhoons and cyclones, bringing death and destruction in their wake. We also know the term, "Nature red in tooth and claw". Animals and birds prey upon each other and when we look closely we find a terrific struggle going on everywhere. Man himself after so many centuries of so-called civilization is still engaged in bloody conflicts. Even after several world wars to eliminate war, there yet is no lasting peace. And in recent times, especially after World War II, so many destructive currents have been let loose. There appears to be a crisis of character. The traditional values are fast changing and one does not feel that man is making progress in all directions.

In music when man had reached such peaks as Beethoven's Ninth Symphony, why should now a stage have been reached when it could be said by some one that modern music covers a "multitude of dins"? Or, when visual art had flowered so magnificently in the work of the Old Masters and in the light-filled canvases of the impressionists, why, again, should it have to come to a level where a cynic could comment: "the most consoling thing about modern art is that things can't be quite as bad as they are painted". When many centuries ago, the unknown sculptor of the time could create, in the brooding darkness of the Elephanta caves, the timeless awe-inspiring image of Shiva, and when at a somewhat later period, Michelangelo could carve the hauntingly beautiful Piétá, why have we come down in modern sculpture to twisted pieces of wood and metal, shapeless or grotesque masses of stone which sometimes are referred to, not by titles, but just by numbers? One recognizes, of course, that there are exceptions to what seems to be the general rule of decline, and dedicated, talented individuals exist.

As mentioned in an earlier paragraph there is a great deal of unrest in the world. An Indian newspaper recently quoted Pope Paul as complaining that the day's news consisted of "lonflicts, wars, revolutions, upheavals, threatening tensions, power struggles and ideological struggles". It appears that generally there has been a great deal of disillusionment. When young, children are told of the wrong things which have been done in the past and they are led to believe mankind is now wiser and that there will be a better life for everybody. But when they grow up they find that the ideals which had been put before them are not being practised by the world at large. In the teaching in schools and colleges old beliefs, old conventions and time-honoured ways of living have been destroyed but nothing worth-while has been given to replace them. Science has dealt a great blow to religion by showing that some of the postulates which have been handed down are untenable in the light of modern knowledge. And religions which have become encrusted with dogma and rituals have not reconciled themselves to the findings of science or made sufficient endeavour to prove their usefulness in modern life. From a comparative study, Trevor Ling comes to the conclusion that the great religions as they exist now are merely vestiges of what were once civilizations. They now consist of theological, ritual and possibly ethical elements only. He argues that each of the great religions was at one time "the expression of a new 'vision' of how human life needed to be organized in order to achieve a true spiritual orientation given a new emerging situation". He further says "Historical changes demand blue-prints for new civilizations, from time to time. Fortunate is the age in which prophets arise who can provide the vision that it needed". There is much in what he says and we are sorely in need of a new vision.

How do we ensure the right use of science? As we have seen, science can give us many many things. But the pursuit of science should not be a dry academic or purely utilitarian undertaking. It should not lead to the state where someone had to declare:

"On the shore of intellect
I forgot how to fly."

Every discovery, according to David Sarneff "reveals more clearly the divine design of nature, remarkable harmony in all things, from the infinitesimal to the infinite. Physical processes and laws imply a Supreme Intellect". How can we plan science teaching so that the student develops not only a mastery of the physical laws of nature but also a respect for and some understanding of the divine design in nature to which David Sarneff refers? How can we build up a race of people who, in the words of Tagore, would pray: "make my life simple and straight, like a flute of reed for thee to fill with music"?

In the earlier part of my address I have referred to the recent advances in agriculture and the hope and confidence which they have aroused that mankind can feed itself and also maintain a certain balance of nature if we think ahead and take the right decisions, including the laying down of a progressive economic policy. I have further indicated very briefly and in the most sketchy terms, the role that science can play in augmenting our resources of food and materials, in finding how to restrain the growth of populations to manageable proportions and how science can give us the blessing of leisure in which to enjoy the fruits of progress. But I have also pointed out how in spite of astonishing discoveries in many fields—man has been able to walk on the moon four times during the very recent past—the greater part of humanity still suffers from lack of food, lack of clothing, lack of housing, lack of education and lack of medical facilities. Above all it seems to suffer from a diminution of the human spirit so that the spirit of contentment seems to be something that is vanishing more and more. What is it that we can do?

One of the great problems in building up and raising humanity to new heights is that while from time to time great leaders and great seers have arisen, there is no genetic mechanism for handing over their achievement to those human beings who follow them. Science has shown quite conclusively that normally acquired characteristics are not inherited. The experience of a life-time can thus be lost. There is a saying in an Eastern country that "experience is a comb which nature gives to man after he is bald." The problem is how to try and preserve the experience and the visions of a higher life which have been perceived by prophetic men. Another great problem is how to utilize the wonders of science so that they are applied for the uplift of man and not merely for material things. How can we prevent science being misused to spread death and destruction and pollution of the environment?

The answer to both of these seems to lie in the creation of a system of education which would, first of all, try to create conditions under which latent talent would be nurtured and developed. We do have some talent search schemes for science, etc., but they tap a pitifully small section of our vast population. Studies conducted a few years ago, by a world authority on the subject, indicated that intelligence and the capacity to produce geniuses is not the monopoly of any one human race. But the well-being of a nation can well depend on the steps which it takes to discover those individuals who are gifted by nature but require the environment to bring out their special qualities. To take an example, India has done well in the world of sports in certain games like tennis and cricket. But what is the proportion of school children in our country who get a chance to handle tennis rackets or cricket bats and balls, leave alone receiving coaching from specialists? There must be many talented children who never receive the opportunity to show what they are capable of. The same applies to science and to other sectors. In a country like ours, there is tremendous scope for identifying at an early age and educating those who could contribute in a substantial way to the future prosperity of the country. The second and most important objective of the system of education must be to teach science in such a way that those who practise it are conscious of the beneficial directions in which they should try to advance, and the harmful directions which should at all costs be avoided. In fact, such a system of education is needed not only for the scientists but for all others who are likely to be concerned with the use of the products of science whether it is for industry or for building up national defence systems, etc. While we cannot do without science we can certainly try to see that education is re-structured to create a society in which the higher values of life will prevail.

This is a difficult task but not an impossible one because as Maurice Frydman has said, "The great achievements of mankind can be always traced to some great and simple intuition, some overwhelming inspiration, taking hold of one man's heart and mind till it becomes for him the most important thing in the world". Even a few devoted persons can in due course of time spread their message in such a way that the bread of life will be leavened.

How do we start doing this? How do we make a blue-print for a new educational system based on science? It seems to me that there is no alternative to assigning this task to a small group of very carefully selected individuals, not those who have hobby horses from which they refuse to dismount but those who are knowledgeable who are filled with dedication to the cause of education and who are willing to give and receive in discussion. A large conference, in which in trying to reach agreed conclusions all is lost in the mediocrity of averages, will not serve the purpose. And once a really gifted group of individuals can lay down the guidelines, these should be considered at the highest level of government and implemented with utmost vigour and speed.

If we can do this and develop a race of mankind which will utilize the fruits of science while suppressing to the maximum extent possible the animal traits which we have inherited from our animal ancestry there may yet be hope for *Homo sapiens*. Nature's gifts to the developing countries are natural resources, the most important among them being the human resources. At present human energy often lies idle and under-developed. To activate and develop resources in the developing countries the need of proper education in all aspects of development is of utmost importance.

Finally, we should ponder upon what is our purpose in life on this earth of ours. Is it only to hunt for food, to reproduce the species, and to sleep? If that were so, man would be no higher in the scheme of things than animals, which also do the same things, sometimes with more grace than we. But if we consciously strive to use science and education to achieve life which is more imbued with the qualities of kindness and mercy, with vision, wisdom and energy, with more of truly human feeling and awe of the grand design of nature, we would be carrying out to some extent the high ideals laid before us by the Mahatma. We would also, by using science properly, pay our tribute to that great scientific spirit whose name the Institute where we are meeting bears.

EXCHANGE CAPACITY OF AMMONIUM PHOSPHOMOLYBDATE FOR CAESIUM BY BATCH TECHNIQUE*

T. M. KRISHNAMOORTHY, G. R. DOSHI AND V. N. SASTRY
Health Physics Division, Bhabha Atomic Research Centre, Bombay-85

INTRODUCTION

EFFORTS have increased within the past few years to search for collecting agents for the low concentration levels of radiocaesium from sea-water. Several reagents used for the precipitation of potassium have been used for concentrating caesium. Among them are the well-known sodium cobaltinitrite[1-3], ammonium phosphomolybdate[4-6], and tetraphenyl boron[7,8]. The ferrocyanides of cobalt, copper, zirconium, iron, nickel[9-12] and cobalticyanides of cobalt[13], zinc and cadmium[14] are also effective scavengers for caesium. It will be useful to have a collecting agent which will have less contamination capacity for K^+ for a direct determination of radiocaesium by gamma spectrometry. Ammonium phosphomolybdate (AMP) in acid solutions (pH ~ 1) carries caesium quantitatively and collects only very small quantities of potassium. The aim of the present investigation is to study the carrying capacity of preformed microcrystalline ammonium phosphomolybdate in single step for caesium at various stable caesium carrier levels and the effect of chemically very similar NH_4^+ ion on caesium recovery.

EXPERIMENTAL

Sets of three 1 litre sea-water samples were acidified to pH 1 with 20 ml of conc. HNO_3 and spiked with known amount of Cs-137 activity [16,000 dpm]. In order to find the minimum amount of AMP needed to carry caesium quantitatively, varying amounts [25–400 mg/1] of preformed microcrystalline AMP [BDH. L.R.] were added to these one litre sea-water samples, stirred and allowed to settle overnight. The precipitate was filtered through millipore filter-paper (0·22 μ size) and the filter-paper was transferred into the counting vial. The precipitates were dissolved in minimum quantities of ammonia, the heights were adjusted to the same as that of the standard and counted in 3″ × 3″ well type NaI (Tl) crystal coupled to a 512 channel Nuclear Data Analyser. The results are shown in Table I. AMP amount needed per litre of sea-water was fixed from these experiments and tests were carried out with 50 litres of sea-water and 200 mg AMP/litre. Results are given in Table II.

TABLE I

Optimum amount of AMP to carry Cs-137 from 1 litre sea-water

No.	Amount of AMP added mg	Cs-137 recovered %	Standard deviation %
1	25	66·7	2·4
2	50	77·7	6·4
3	100	96·0	4·2
4	200	96·6	4·1
5	400	95·7	2·3

TABLE II

Recovery of Cs-137 from 50 litres sea-water

No.	Cs-137 activity (cpm)		Recovery %
	Added	Recovered	
1	4129	4025	97·5
2	4129	4032	97·7

TABLE III

Effect of NH_4^+ ion on the recovery of Cs-137 from 1 litre sea-water

No.	Conc. of NH_4^+ g/l	Cs-137 recovered %	Standard deviation %
1	0·17	99·2	1·0
2	0·33	98·0	1·4
3	1·00	79·4	2·4
4	2·00	56·0	3·6
5	3·00	46·1	2·5
6	5·00	31·0	2·6

The effect of ammonium ion on the recovery of Cs-137 from sea-water was examined (Table III). 1 litre of filtered sea-water samples were acidified to pH 1 with 20 ml of conc. HNO_3 and spiked with known amount of Cs-137 activity. Varying amounts of ammonium chloride were added and the carrying capacity for Cs-137 on 200 mg AMP was studied.

---

* Contribution to BARC/IAEA Research Agreement No. 155/R5/CF.

TABLE IV

Effect of caesium carrier on Cs-137 recovery from 1 litre sea-water

No.	Cs carrier added mg	Cs–137 recovery %	Standard deviation %
1	Nil	96·6	4·1
2	0·02	95·5	3·9
3	0·05	99·8	1·0
4	0·10	99·0	1·0
5	0·20	95·8	2·7
6	0·50	99·8	1·0
7	5·0	99·7	1·0
8	10·0	100·0	1·0
9	20·0	76·0	3·6
10	30·0	54·5	1·2
11	40·0	42·1	1·9
12	61·0	30·0	1·0

In order to study the amount of natural caesium that can be picked up per unit weight of AMP, experiments were conducted with varying concentrations of natural caesium (along with Cs-137) in one litre of acidified sea-water samples. 200 mg AMP was used to carry caesium. Results are shown in Table IV.

DISCUSSION

It is seen from Table I that AMP quantities greater than 100 mg are sufficient to carry Cs-137 quantitatively from 1 litre of sea-water. Rocco and Broecker[5] have concluded from their preliminary studies that 250 mg AMP per litre is sufficient to carry 90% of Cs-137 added. Further they state that it is not necessary to employ six times larger amounts of AMP per litre used by Miyake *et al.*[15]. For their field investigations, Rocco and Broecker have used 160 mg AMP/litre and caesium recovery averages to 55% even after the large number of steps used. Folsom[12] and co-workers have used 400 mg AMP per litre and they recommend that this quantity is needed for quantitative recovery of Cs-137 from sea-water. However, the present results indicate that no loss of caesium occurs even at AMP levels as low as 100 mg per litre. In the absence of practical problems, the safer limit of 200 mg AMP per litre can be employed even for large volumes of sea-water. The removal efficiency is confirmed by the results shown in Table II. The level of 200 mg AMP per litre yields $98 \cdot 3 \pm 2 \cdot 3\%$ for the recovery of Cs-137 in presence of natural caesium, which corresponds to a K_d value of $> 10^5$ compared to the value of 5×10^4 reported by Folsom and Sree Kumaran[12].

Dr. Bowen in a personal communication states "when Cs-137 was collected on AMP after ferric hydroxide precipitation (with ammonia), the mean Cs-137 found was not changed but the variance about the mean (batches of eight replicate samples) was about 3 times higher than when collected on AMP before the hydroxide precipitation". It is seen from Table III that ammonium ion concentrations upto 0·33 g/litre do not have recognizable inhibiting effect on the recovery of Cs-137. Increased amounts of ammonium ion compete with caesium exchange on AMP. Yamagata and Yamagata[16] have also studied this effect in 100 ml of artificially prepared salt solutions to simulate the composition of food, urine or biological tissues. Their conclusions based on *in situ* precipitations of AMP are quite similar with ours. The fact that the quantities of ammonium ion less than or equal to 1 g NH_4^+ per litre do not inhibit Cs-137 recovery in their studies, is mainly due to six times larger amounts of AMP and *in situ* precipitation employed by them. It is interesting to note that in 0·1 M NH_4^+ concentration, the K_d value of 6,000 obtained by Smit[17] using column technique agrees well with the K_d value of 7,000 obtained in the present work at the same concentration.

The carrier caesium upto 10 mg does not affect the recovery of Cs-137 from 1 litre sea-water (Table IV). Hence, from tracer concentrations upto 10 mg of caesium can be quantitatively removed on AMP from acid solutions. The maximum amount of caesium that is held on 200 mg AMP is about 18 mg, thus the ion exchange capacity of AMP by these batch studies works out to be 0·7 meq Cs/g, (*Cf* Table IV) which is about 45% of the exchangeable NH_4^+ (1·57 meq/g)[18].

The major conclusions of the present work are :

(1) 100 mg AMP is sufficient to carry Cs-137 quantitatively from 1 litre of sea-water.

(2) With 200 mg AMP, 10 mg caesium can be quantitatively carried from 1 litre of sea-water, and

(3) NH_4^+ concentrations higher than 0·33 g/l interfere with the carrying of Cs-137 when 200 mg AMP is used per litre of sea-water.

ACKNOWLEDGEMENT

Our sincere thanks are due to Dr. A. K. Ganguly, Head, Health Physics Division, for his keen interest and helpful criticism.

---

1. Smales, A. A. and Solmon, L., *Analyst*, 1955, **80**, 37.
2. Folsom, T. R., Mohan Rao, G. J. and Winchell, P., *Nature, Lond.*, 1960, **187**, 480.
3. Schroeder, B. W. and Cherry, R. D., *Ibid.*, 1962, **194**, 669.
4. Kahn, B, Smith. D. K. and Straub, C. P. *Anal. Chem.*, 1957, **29**, 1210.
5. Rocco, G. G. and Broecker, W. S., *J. Geophys. Res.*, 1963, **68**, 4501.
6. Morgan, A. and Arkell, G. M., *Hlth. Phys.*, 1963, **9**, 857.
7. Jones, N. E., *USAEC Rept. KAPL—1378*, 1955.
8. Handley, T. H. and Burros, C. L., *Anal. Chem.*, 1959, **31**, 332.
9. Schultz, W. W. and Mekenzie, T. R., *USAEC Rep. TID—7517*, 1956.
10. Makenzie, T. R., *USAEC Rep. HW—47761*, 1957.
11. Mohan Rao, G. J. and Folsom, T. R., *Analyst*, 1963, **88**, 105.
12. Folson, T. R. and Sree Kumaran, C., Reprinted from "Reference Methods for Marine Radioactivity Studies," *Tech. Rep. No. 118 IAEA*, Vienna, 1970.
13. Langford, J. C., *USAEC Rep. HW—49668*, 1957.
14. Scheider, R. A., *USAEC Rep. HW—46488*, 1956.
15. Miyake, Y., Saruhashi, K., Katsuragi, Y. and Kanazawa, T., *J. Radiat. Res.*, 1961, **2**, 25.
16. Yamagata, N., Yamagata, T., *Bull. Chem. Soc.*, Japan, 1958, **31**, 1063.
17. Smit, J., Van, R., *Nature*, 1958, **181**, 1530.
18. —, —, Robb, W. and Jacobs, J. J., *J. Inorg. Nucl. Chem.*, 1960, **12**, 104.

OBSERVATIONS ON THE CYTOLOGY OF THE MADRAS MINT

E. K. JANAKI AMMAL
Centre for Advanced Studies in Botany, University of Madras

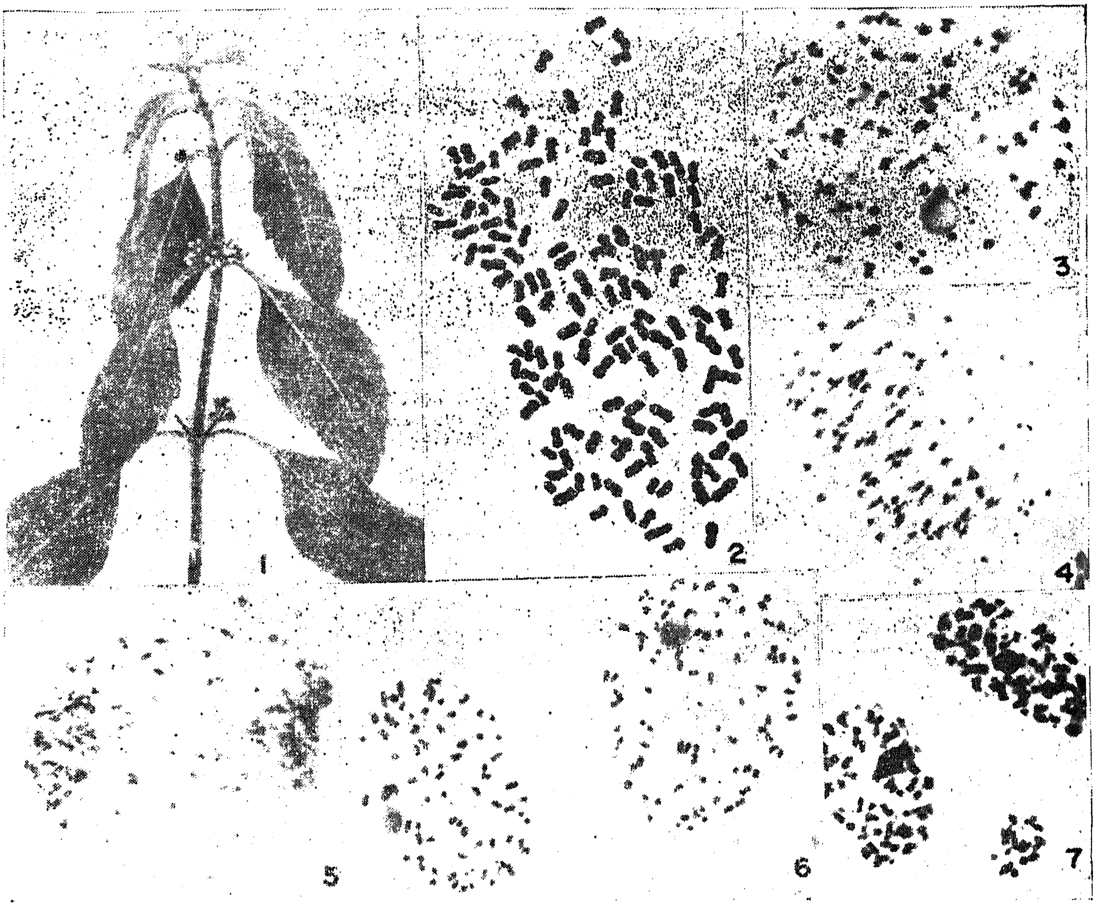
AND

T. V. SREENIVASAN
Sugarcane Breeding Institute, Coimbatore-7

THE term mint, often applied to various species of *Labiatae*, is most frequently used to designate plants of the genus *Mentha* in which are included about 30 species of perennial herbs which are natives of the North Temperate Zone. Mints hybridize freely in nature, giving rise to integrating forms which make the limitations of certain species difficult. They have been in cultivation from ancient times for their aromatic oils which are used in culinary preparations, in medicine and perfumery.

Cytologically the genus *Mentha* falls into two well-defined groups. The *Pennyroyal* or *Pulegium* group with a basic number $x = 10$ which is confined to the Mediterranean region and the "*Spicata-Arvensis*" group with basic number $x = 6$ or $x = 12$ which has a much wider distribution. The lowest chromosome number of this group is found in *M. longifolia* which has 24 chromosomes. Polyploidy is common in this group with chromosome numbers $2n = 48$ and 72 in *M. piperata* and $2n = 96$ in *M. arvensis*, *M. citrata* and *M. aquatica* (Sobti, 1965). *M. arvensis* vari *piperascens*, popularly known as the "Japanese mint", was introduced into India and is now extensively grown for the production of menthol. A colchiploid of the Japanese mint with $2n = 192$ chromosomes was produced at the Regional Research Laboratory, Jammu, in 1960 (Janaki Ammal and Sobti, 1962). It is more robust but has thicker stems than the Japanese mint which is a disadvantage in commercial cultivation. To rectify this defect the Jammu mint was backcrossed with the Japanese mint. The progeny was found to be intermediate in vegetative characters (Fig. 1). Roots tip squashes of the hybrid showed $2n = 144$ chromosomes (Fig. 2), and it may therefore be considered as a "triploid" form of the Japanese mint. It flowered for the first time at the Botany Field Research Station of the University of Madras in 1970 and has thus been designated as the "Madras mint".

Meiosis was studied in pollen mother cells and the 144 chromosomes were found to be associated chiefly as bivalents and univalents with occasional trivalents and quadrivalents (Figs. 3 and 4). Table I shows the chromosome associations observed in eight pollen mother cells. Univalents at anaphase were found to divide resulting in different chromosome numbers in daughter cells (Figs. 5 and 6). Univalents which failed to congress on the metaphase plate often formed micronuclei (Fig. 7). Anthers were non-dehiscent and were found to be completely sterile.



FIGS. 1–7. Fig. 1. Flowering branch of the Madras mint (¼ natural size). Fig. 2. Root tip squash of the Madras mint showing 144 chromosomes (× 1,000). Figs. 3–4. Diakinesis and Metaphase showing univalents, bivalents and multivalents in PMCs (× 2,000). Fig 5. Anaphase in PMC showing division of univalents (× 2,000). Fig. 6. Telophase with unequal number of chromosomes (× 1,700). Fig. 7. Telophase with micronuclei (× 2,000).

TABLE I

Chromosome association in the Madras mint

S. No.	Quadrivalents	Trivalents	Bivalents	Univalents	Total
1	..	..	60	24	144
2	..	..	52	40	144
3	1	1	52	33	144
4	..	2	54	30	144
5	1	3	48	33	144
6	..	..	58	28	144
7	5	..	44	36	144
8	..	..	48	48	144

The Madras mint is being propagated at Madras and Coimbatore to study its oil content at different locations so that its potentiality as a commercial crop can be exploited.

---

1. Janaki Ammal, E. K. and Sobti, S. N., "The origin of the Jammu mint," *Curr. Sci.*, 1962, **31**, **387**.
2. Sobti, S. N., "Chromosome numbers in species of *Mentha*," *Proc. Indian Acad Sci.*, 1965, **62 (3)**, **145**.

LETTERS TO THE EDITOR

ULTRASONIC INTERFEROMETER WITH PIEZOELECTRIC CERAMICS

A composite ultrasonic interferometer with two-matched quartz crystals is in use in this laboratory and its working in detail has been reported earlier[1]. The quartz crystals can be excited only at their resonant frequencies and their odd harmonics. As such, continuous frequency operation with quartz crystals is not possible. To overcome this difficulty an interferometer employing two identical lead zirconate titanate ceramics has been designed. Its performance has been studied and reported in this communication.

The piezoelectric ceramics[2,3] have certain advantages over quartz as transducers in an interferometer. They respond over a frequency range unlike quartz crystals. Their piezoelectric constant is very high and as such they deliver more acoustic output than quartz. However, the ceramics have certain disadvantages. They cannot be directly coupled to and excited by an R.F. oscillator because of their high dielectric constant and low impedance. As such, indirect coupling to the oscillator is desirable. They get easily heated and give rise to undesirable local heating of the test liquid if powerfully excited. Therefore, the oscillator has to be worked always at a low power.

Keeping the above points in view, velocity measurements in a few standard liquids have been made and compared with those obtained by quartz interferometer. The experimental details and the thermostat employed are the same as in the case of the composite ultrasonic interferometer. The ceramics used have a characteristic frequency of 1,300 KHz. The temperature is controlled to an accuracy of ± 0·1° C. The frequency of investigation is 1 MHz. The results obtained are presented in Table I. The values agree fairly well with those reported in the literature[4,5].

In view of its ability to work over a frequency range, the double ceramic interferometer is particularly suitable for velocity dispersion studies in fluids. Its frequency of operation can be continuously varied from 1 MHz. to 3·30 MHz. The parallelism between the ceramics is found not critical as in the case of quartz interferometer because of their high piezoelectric output.

TABLE I

Liquid	Temperature °C	Velocity (m/sec)		
		Ceramic interferometer	Quartz interferometer	Literature values
Carbon tetrachloride	30·0	905	908	904
Benzene ..	25·0	1292	1295	1301
Xylene ..	25·0	1332	1334	1335
Carbon disulphide	25·0	1146	1145	1143
Water ..	30·5	1510	1509	1511

Dept. of Physics, C. RAGHUPATHI RAO.
Osmania University,
Hyderabad-7, (A.P.), *July* 21, 1971.

---

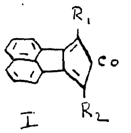
1. Rao, C. R., Rao, P. S. R. K. and Subrahmanyam, P., *Indian J. pure appl. phys.*, 1968, **6**, 638.
2. Rao, S. R., *Ibid.*, 1970, **8**, 848.
3. Mason, W. P., *Piezoelectric Crystals and Their Application to Ultrasonics*, 1954, p. 291.
4. Bergmann, L., *Der Ultraschall*, 1949.
5. *Handbuck der Physik* (*Akustik* 1), 1961, 11.

SYNTHESIS OF 7, 14-DISUBSTITUTED ACENAPHTHO (1, 2-*k*) FLUORANTHENES

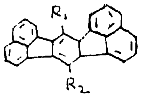
WE have undertaken the synthesis of 7, 14-disubstituted acenaphtho (1, 2-*k*) fluoranthenes from the standpoint of their chemical, spectral and carcinogenic properties. Only two 7, 14-disubstituted acenaphtho (1, 2-*k*) fluoranthenes are described in the literature[1,2]. In the present communication the methods of preparation of several of these are discussed.

The syntheses of these acenaphtho (1, 2-*k*) fluoranthenes were accomplished directly through Diene Synthesis. The dienones (1) were prepared by the reaction between acenaphthaquinone and various types of ketones having two reactive α-methylene groups. The dienophile used was acenaphthylene. The condensation reactions were carried out directly by heating the dienones (1) and acenaphthylene at 130–140° without the use of any solvent. The reaction took place with the elimination of carbon monoxide. The resulting dihydro compounds (II), obtained in good yields, underwent ready aromatisation to the corresponding 7, 14-disubstituted acenaphtho (1, 2-*k*) fluoranthenes (III) when refluxed in tetralin for three hours or boiled in xylene for a long time. These 7, 14-disubstituted acenaphtho (1, 2-*k*) fluoranthenes can also be obtained directly by the use of chloranil, a dehydrogenating agent, during the condensation reaction between the dienones (I) and acenaphthylene.

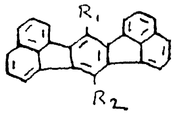
TABLE I



I



II



III

	R_1	R_2	M.P. °C	
			(II)	(III)
I	CH_3	CH_3	236	>322
II	C_2H_5	C_2H_5	204	322
III	n-C_3H_7	n-C_3H_7	183	309
IV	n-C_4H_9	n-C_4H_9	164	280
V	n-C_5H_{11}	n-C_5H_{11}	125	236
VI	C_6H_5	CH_3	189	249
VII	C_6H_5	n-C_3H_7	194	275

The compounds (II) were crystallised from benzene and alcohol mixture and compounds (III) were crystallised from chloroform. Melting points are not corrected. Micro analyses were done in Alfred Bernhardts Laboratory, W. Germany.

Organic Chemistry Laboratory,
University of Burdwan,
Burdwan, West Bengal, *January*, 11, 1971.

A. J. BHATTACHARJEE.
S. N MANDAL

---

1. Tucker, S. H., *J. Chem. Soc.*, 1958 (1946).
2. Dilthey, W., Henkles, S. and Schaefer, A., *Bur. dtsch. Chem. Ges.*, 1938, **71**, 974.

SOME TRIVALENT METAL COMPLEXES OF O-HYDROXY KETOXIMES

THE metal chelates of Cu^{2+}, Ni^{2+} and Co^{2+} have been studied by some authors[1,2].

The metal chelates of Cr^{3+}, Mn^{3+} and Fe^{3+} with the ligand, 2-hydroxy-5-methyl acetophenonoxime, have been studied here. They all are stable in the pH range 6–8. They are quite stable in air. All are insoluble in water and soluble in organic solvents—the solubility of the ferric complex in benzene, etc., is remarkable indeed. They can be used as reagents for the gravimetric estimation of these three ions. They are all 1 : 3 complexes as shown by their elemental analysis and Job's method by extraction into chloroform. Their molecular weights, determined cryoscopically, show them to be monomeric. They are, thus, assigned an octahedral structure.

Their magnetic moments are $\mu\,Cr^{3+} = 3{\cdot}75$ B.M., $\mu\,Mn^{3+} = 4{\cdot}90$ B.M., $\mu\,Fe^{3+} = 5{\cdot}9$ B.M. These are consistent with an octahedral[3] structure with 3, 4 and 5 unpaired electrons. The magnetic moments indicate a weak or medium strength for this ligand. The ligand spectra in organic solvents are eclipsed by a strong charge transfer absorption and hence no ligand field calculations could be made. The chelates have, however, the typical free ion colours: CrL_3 (green), MnL_3 (brown) and FeL_3 (reddish-brown), indicating a weak ligand.

We are grateful to Prof. R. D. Patel of Sardar Patel University for use of equipment for mangetic and spectral studies.

Bhavan's College,
Dakor, *July* 13, 1971.

L. D. DAVE.
K. R. PATEL.

---

1. Pandya, *Ph.D. Thesis*, Gujarat University, India, 1963.
2. Harisinh and Kailashchandra Sharma, *Ind. Jour. Appl. Chem.*, 1965, **28**, 1.
3. Earnshaw, A., *Introduction to Magnetochemistry*, 1968, p. 35.

A NEW COLOUR TEST FOR THE DETECTION OF SULPHITE ION BASED ON BÖDEKER'S REACTION

ONLY few simple and reliable colour tests[1-5] are available in literature for the detection of sulphite ion. Bödeker[1,2] was the first to describe a novel colour reaction for the sulphite ion involving the latter's treatment with sodium nitroprusside, when a red coloration develops due to the formation of sulphitonitroprusside ion[6,7] $[Fe(CN)_5NO.SO_3]^{4-}$. The addition of metal ions (Zn, Cd, and Ni)[1,2,8-10] and organic bases (hexamine and pyridine)[9-11] to the Bödeker's reaction was found to markedly increase the sensitivity and intensity of the coloured product formed in the test.

The present communication describes a simple, rapid, colour reaction for the sulphite ion, principally based on Bödeker's reaction. The new reaction involves the use of thiourea and an hitherto unused metal ion, copper (II). The test essentially consists in the reaction of sodium nitroprusside solution with a solution of copper (II) ions, when a light green coloured precipitate of cupric nitroprusside, Cu [Fe

$(CN)_5NO]$, is formed. On the addition of thiourea solution, the precipitate dissolves completely, giving a colourless and soluble complex $[Cu\ (tu)_x] \cdot [Fe\ (CN)_5\ NO]$, where $x = \leqslant 4$. When a neutral solution of sulphite is added to the resultant thiourea-copper (II)-nitroprusside complex solution, a heavy reddish-pink or red precipitate of thiourea-copper (II)-sulphito-nitroprusside complex, is obtained. Presumably, the latter complex has the structure $[Cu\ (tu)_x]_2\ [Fe\ (CN)_5\ NO.SO_3]$; where $x = \leqslant 4$. This structure is based on the fact that the maximum co-ordination number of copper (II) is six[12].

The following stock solutions were used in analysis :

(A) *Sodium sulphite solution* 1% w/v Na_2SO_3 (anhydrous) in water ; (B) *Sodium nitroprusside solution* 5% w/v $Na_2\ [Fe\ (CN)_5\ NO] \cdot 2\ H_2O$ in water ; (C) *Thiourea solution* 5% and 15% w/v in water ; (D) *Cupric chloride solution* 2·5% w/v $CuCl_2$ in water ; or (E) *Cupric sulphate solution* 3% w/v $CuSO_4 \cdot 7\ H_2O$ in water.

Procedure for the Micro Detection of Sulphite Ion.—Place 1 drop of 2·5% cupric chloride (D) [or 3% cupric sulphate (E)] solution followed by a drop of 5% sodium nitroprusside solution (B) in the depression of a spot plate. A light green coloured precipitate of cupric nitroprusside forms. Add a drop of 15% thiourea solution (C), and stir. The precipitate dissolves almost completely. Then add a very minute quantity of the solid test sample (1 or 2 very small crystals are sufficient) or 2 drops of its neutral solution, and stir the reaction mixture. A positive response is indicated by the formation of a heavy reddish-pink or red precipitate.

Limit of detection : 1 μg SO_3^{2-} ion. *Limit of dilution* : 1 : 50,000.

Procedure for the Macro Detection of Sulphite Ion.—To 1 ml of solution (D) or (E), add 1 ml of solution (B). To the resultant precipitate, add 5% solution (C) dropwise with shaking until the precipitate just dissolves and an almost colourless solution results. Then add 1-2 ml of the sulphite solution (or a little solid) to be tested. The immediate formation of a reddish-pink or red precipitate indicates the presence of SO_3^{2-} ion. The red precipitate dissolves completely on heating, giving a colourless solution. The precipitate does not reappear on cooling, but on adding more of sulphite solution or solid, it again comes out.

The excess addition of thiourea solution in the above test must be avoided as it causes a decrease in the intensity of the colour of the precipitate that ultimately forms. Sometimes, the test fails altogether in presence of large excess of thiourea.

In the detection of sulphite ion by the present method, no interference is caused by sulphates and small amounts of thiosulphates. In presence of large amounts of thiosulphates, the intensity of the red colouration is greatly diminished. Sulphides invariably interfere with the test. The interference caused by sulphides and thiosulphates may be overcome by their precipitation by pretreatment with mercuric chloride solution[2] (which precipitates out sulphide as HgS), and then performing the test with the filtrate. The mercuric chloride treatment also removes thiosulphates.

Dept. of Chemistry, G. S. JOHAR.
V.S.S.D. College, J. P. SINGH.
Kanpur-2, (MISS) G. MAJUMDAR.
July 19, 1971.

1. Bödeker, C., *Ann.*, 1861, **117**, 193.
2. Feigl, F., *Spot Tests in Inorganic Analysis*, 5th Eng. Ed., (Fourth Reprint, 1967), Elsivier, Amsterdam, 1958, pp. 307–300.
3. Estalella, *J. Anales. soc. espan. fis. y quim.*, 1922, **20**, 271 ; Rosenthaler, L., *Mikrochem.*, 1927, **5**, 27.
4. Rudnitzkit, Z., *J. Appl. Chem. USSR.*, 1934, **7**, 402.
5. Grant, J. and Booth, J. H. W., *Analyst*, 1932, **57**, 514.
6. Dworzak, R., Becht, K. H., Reitter, L. and Ruf, E., *Z. Anorg. Chem.*, 1956, **285**, 143.
7. Moser, W., Chalmers, R. A. and Fogg, A. G., *J. Inorg. Nucl. Chem.*, 1965, **27**, 831.
8. Pavolini, T., *Bull. Chim. Pharm*,, 1930, **69**, 713, 719.
9. Scagliarini, G., *Atti IV Congr. Nazl. Chim. Pura Applicata*, 1932, **1933**, 597.
10. —. *Atti Acad, Lincei*, 1935, **22**, 155.
11. Fogg, A. G., Moser. W. and Chalmers, R. A., *Anal. Chim. Acta*, 1966, **36**, 248.
12. Jones, M. M., *Elementary Co-ordination Chemistry*, Prentice Hall, Inc., New Jersey, 1964, p. 41.

PHYTOCHEMICAL STUDY OF *ARGEMONE MEXICANA* LINN. LATEX

BY the general alkaloid extraction procedure the alkaloids were extracted from the latex (20 g) of *Argemone mexicana* Linn. and fractionated as water soluble and water insoluble portions which were designated as "Fraction A" (0·4 g) and "Fraction B" (0·2 g) respectively.

TLC [silica gel, solvent system : (*a*) *n*-butanol : HCl (94 : 6) saturated with water, (*b*) *n*-butanol : HCl (80 : 20) saturated with water] of the Fraction 'A' suggested that it contains one alkaloid. Fraction 'A' was dissolved in water about (4 ml), for purification adsorbed on alumina column and eluted with water (100 ml). The substance in the eluate was identified as Berberine (0·74%) m.p. and mixed m.p. 145°. The aqueous solution was bitter, neutral to litmus and optically inactive. The identity of the alkaloid was further confirmed by paper and TLC by comparison with an authentic sample of berberine.

Paper and TLC of Fraction 'B' indicated the presence of two bases. Fraction 'B' was dissolved in chloroform about (5 ml) and resolved on alumina column (30 g) and was eluted with chloroform. The first portion of chloroform eluate (80 ml) indicated the presence of a base but which could not be identified as it failed to crystallize in different solvents but the later portion of chloroform eluate, after evaporation gave protopine (0·36%) which was recrystallized by using chloroform containing little alcohol. It showed crystals, m.p. 208° which was undepressed when mixed with authentic protopine. The identification of protopine was further confirmed by paper and thin-layer chromatography [silica gel, *n*-butanol : HCl (94 : 6) saturated with water] by comparison with authentic sample of protopine and by following chemical tests. The base was soluble in acetic acid which with strong sulphuric acid gave blue-violet solution and finally changed to red on adding water; sulphovanadic acid gave reddish-violet colour which later on changed to deep blue.

Free Amino-Acids.— Latex was macerated with 70% ethanol for one hour, the ethanolic extract was separated by centrifuging while the residue was extracted with a fresh portion of the same solvent, centrifuged again and the centrifugate removed. The process of extraction was repeated thrice and the whole of the alcoholic extract thus obtained concentrated in vacuo to small volume. Aliquot portion of the same was then used for paper chromatographic screening [Whatman No. 1, descending, *n*-butanol: glacial acetic acid: water (4 : 1 : 1)]. The paper was equilibrated for twenty-four hours in an atmosphere saturated with the solvent mixture. A 0·1% solution of ninhydrin in water-saturated butanol was used for spraying of the chromatograms. The amino-acids were identified from chromatograms by comparing with known authentic amino-acids. The above chromatographic screening indicated the presence of L. glutamine, hydroxyproline, threonine, *β*-alanine and methionine as free amino-acids in latex.

The authors are thankful to Dr. B. R. Pai, Presidency College, Madras, for the supply of authentic samples of protopine and berberine alkaloids.

Dept. of Pharmaceutical Sciences,
University Campus,
Nagpur (Maharashtra), *July* 3, 1971.

D. K. SANTRA.
A. N. SAOJI.

---

1. Chopra, R. N., Chopra, I. C., Handa, K. L. and Kapur, L. D., *Chopra's Indigenous Drugs of India*, U. N. Dhur & Sons Pvt. Ltd., Calcutta-12, 1958, p. 283.
2. Srivastava, G. N., Chakravarti, R. N. and Zaidi, S. H., *Ind. J. Med. Sci.*, 1962, **16**, 873.

LOW GRADE METAMORPHISM OF 'GREEN EARTH' FROM PASHAN, POONA

'GREEN EARTH' is commonly associated with the Deccan Traps as thin linings on cavities, cooling walls or joint surfaces. It is characteristically green in colour with a dull earthy appearance. Microscopic study shows that it is usually composed of glass, glauconite and small quantities of chlorite chalcedony, etc.

During the course of field work around Pashan near Poona the writer observed green earth showing an unusual opalescence. It occurs as a thin lining on silica veins along joint planes. Groove lineations suggestive of slickensides are present on the surface. Microscopic examination showed the presence of the assemblage, quartz—pumpellyite—epidote—chlorite, which is characteristic of the prehnite-pumpellyite metagraywacke facies of low grade metamorphism (Coombs, 1960). Occurrence of pumpellyite in lowly metamorphosed mafic lavas, intrusives, graywackes, and tuffs, etc., have been reported from various parts of the world (Coombs, 1953; Seki, 1961). However, this mineral has not been hitherto recorded in the Deccan Traps.

A reference to Coombs' diagram showing stability pattern of metamorphic calcium-aluminium silicate indicates, for the Pashan green earth, recrystallisation temperature of about 300° C at about 2–3 Kb pressure. Such a pressure if developed due to superincumbent load would require an over-burden of 7-11 km thickness (Winkler, 1967). This seems unlikely in the case of Deccan Traps; a conclusion substantiated the fact that the mineral assemblage under discussion is not found in the green earths of surrounding areas. The required stress is most likely to have developed due to slippage which gave rise to the observed slickensides.

The writer expresses his grateful thanks to Prof. B. G. Deshpande for constant encouragement during the work.

Dept. of Geology, N. S. GHATE.
University of Poona,
Poona, *July* 10, 1971.

---

1. Coombs, D. S., "The pumpellyite mineral series," *Min. Mag.*, 1953, **30**, 113.
2. —, "Lower grade mineral facies in New Zealand," *IGC., XXI, Norden*, 1960, **13**, 339.
3. Seki, Y., "Pumpellyite in low grade metamorphism," *Jour. Pet.*, 1961, **2**, 407.
4. Winkler, H. G. F., *Petrogenesis of Metamorphic Rocks*, 2nd Ed., Springer-Verlag, N.Y., 1967, p. 237.

STRUCTURE OF THE NOSE IN SOME INDIAN TELEOSTEAN FISHES

THE anatomy of the nose in teleostean fishes has been described by earlier workers[1-10] though Indian species have so far not been investigated. The present authors have studied the functional anatomy of the olfactory organs in some Indian fishes (*Labeo rohita, Garra gotyla, Wallago attu, Sisor rabdophorus, Glyptothorax telchitta, Channa punctatus, Muraena undulata* and *Cynoglossus oligolepis*) representing different taxonomic levels and varying habitats. The olfactory organs in each of these species are paired structures, each organ opening to the outside by an anterior and a posterior opening. In *L. rohita, G. gotyla, S. rabdophorus* and *G. telchitta*, the two openings are simple, oval or circular perforations; they lie close together and are separated from each other by a nasal flap which serves to deflect the water into the anterior opening during forward progression of the fish. In *W. attu, C. punctatus, M. undulata* and *C. oligolepis*, the anterior and posterior openings lie at a distance from one another; the anterior opening in the last three species is borne on a forwardly and outwardly directed tube while that in *W. attu* is supported on a funnel-shaped outgrowth. The posterior opening in *W. attu* and *C. oligolepis* is valved.

The olfactory rosettes in *L. rohita, G. gotyla, S. rabdophorus* and *G. telchitta* are oval in shape with their lamellae arranged on either side of a linear raphe (Bateson's[1] rosette type 3; Burne's[2] rosette column I). *W. attu, M. undulata* and *C. oligolepis* have elongated rosettes with the lamellae arranged on either side of a long and narrow raphe (Bateson's[1] rosette type 2; Burn's[2] rosette column II). The rosette of *C. punctatus* is devoid of a raphe and its lamellae are arranged parallel to the anteroposterior axis of the body of the fish (Bateson's[1] rosette type 4; Burne's[2] rosette column IV). The rosette on the left pigmented side of the body of *C. oligolepis* is comparatively much better developed than that on the right unpigmented side; the former is oriented roughly perpendicular to the anteroposterior axis of the body of the fish while the latter extends parallel to it.

The number of lamellae in the olfactory rosettes of all the studied fishes was found to increase with the growth of the fishes. In *C. punctatus*, the increase in their number occurred at the lateral ends of the rosette while in the left rosette of *C. oligolepis* it occurred at its dorsal and ventral ends. In the right rosette of *C. oligolepis* and in the rosettes of the rest of the species the number of lamellae showed an increase at the anterior end. The ratio between the total olfactory and retinal areas has been determined in each of the species studied. On the basis of the data so obtained, an attempt has been made to establish if a particular species had olfaction as the dominant sense compared to vision or *vice versa*. *G. gotyla, W. attu, G. telchitta, M. undulata* and *C. oligolepis* have been found to possess a predominantly developed sense of olfaction; these are, therefore, macrosomatic species and may be classified under Teichmann's[3] group 3. *L. rohita* and *C. punctatus* are endowed with a more or less equally well-developed optical and olfactory faculties and should fall under Teichmann's[3] group 1. *S. rabdophorus* belongs to Teichmann's[3] group 4 (provisional) with both eyes and olfactory organs poorly but equally developed.

We are of the opinion that Teichmann's[3] attempt to link the olfactory faculty of a fish with the shape of its rosette is questionable.

Of the eight species studied, accessory nasal sacs occur in *L. rohita, C. punctatus* and *C. oligolepis*. *L. rohita* has a single anterior ventral sac, homologous to the lachrymal sac of Burne[2]; *C. punctatus* has two sacs—one dorsomesial and the other ventromesial, comparable to Burne's[2] ethmoidal and lachrymal sacs, respectively; and *C. oligolepis* has an unpaired sac with its floor attached to the dorsal wall of the buccal cavity. Accessory sacs function as a pumping device for effecting replacement of water in the olfactory cavity of the fish and their dilatation and compression are caused by the movements of the jaw bones which are generally synchronized with the breathing movements of the fish. We have observed that these sacs are able to draw water into the olfactory chamber through both the anterior and posterior nasal openings; however, expulsion of water always takes place through the latter. It has been concluded that accessory sacs are invariably present in sedentary or semi-sedentary fishes; in actively swimming fishes, however, they may or may not be present.

Department of Zoology, P. P. OJHA.
University of Rajasthan, A. S. KAPOOR.
Jaipur (India), *July* 3, 1971.

---

1. Bateson, W., *J. Marine Biol. Assoc. London*, 1889, **1**, 225.
2. Burne, R. H., *Proc. Zool. Soc. London*, 1909, **2**, 610.
3. Teichmann, H., *Z. Morph. Ökol. Tiere*, 1954, **43**, 171.
4. Derscheid, J. M., *Ann. Soc. Roy. Zool. Belg.*, 1924, **54**, 79.
5. Van den Berghe, L., *Bull. Acad. Roy. Belg. Sci. Lettr. Beaux Arts.*, 1929, **15**, 278.
6. Liermann, K., *Z. Anat. Entwicklung.*, 1933, **100**, 1.
7. Branson, B. A., *J. Morph.*, 1963, **113**, 215.
8. Gooding, R. M., *FAO Fish. Rept.*, 1963, **3**, 1621.
9 Pfeiffer, W., *Can. J. Zool.*, 1963, **41**, 1233.
10. —, *Ibid.* 1965, **43**, 223.

IDIOFIBROSCLEREID—A DESCRIPTIVE TERM FOR WANDERING MESOPHYLL FIBRES

THE association of fibres with foliar tracheary elements is a widespread phenomenon in many seed plants. In the majority of the investigated species they are found to closely accompany the spirally thickened foliar veins and veinlets. In certain cases they show some deviations and often intrude into the adjacent mesophyll or sometimes extend beyond the vein-endings (Fig. 1).

The correct designation of such fibre-like elements presents a problem in terminology. Several terms like fibrovasal cambiform[1], sclerenchymatous idioblasts[2-4], extraxylary wandering fibres[5-6], fibriform sclereids[7], strands of thick-walled fibres[8-9] and foliar sclereids[10] are used to describe such types of fibres which accompany the foliar veins and veinlets.

The pattern of distribution of these fibre-like sclereids is of significant morphological interest. They vary from simple elongated fibres, to short fibres with or without branching, intruding into the adjacent mesophyll. Sometimes, they are independently disposed more or less parallel to the tracheary elements. In some species they are very much branched and in transections appear like idioblastic sclereids[9-10]. Ontogenetically it has been shown in *Manilkara hexandra* (Roxb.)[4] Dubard and *Cynometra polyandra* L.[11] that the initials of these fibres are transformed spongy cells situated near the differentiating procambial strands. So, it is evident that these elements are more or less intermediate between idioblastic sclereids and strands of fibres. They do not fit into any distinct type of new sclereids recognised by many workers. Hence the term idiofibrosclereid has been proposed to such fibre-like forms which accompany tracheary elements which assume a variety of peculiar shapes.

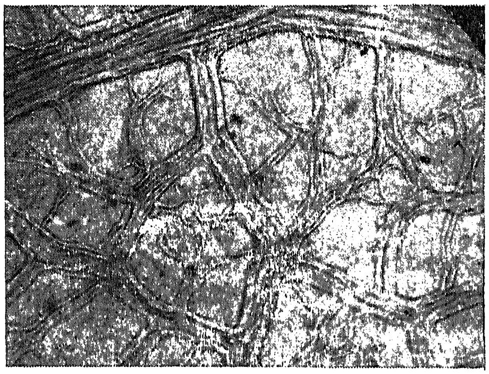


FIG. 1. Cleared lamina of *Loropetalaum chinense* Oliv. showing idiofibrosclereids, × 40.

Idiofibrosclereids are sparingly or profusely developed in the leaf expanses and are readily observed in cleared leaf sectors of many taxa of phanerogams. Due to failure of earlier workers in applying a suitable clearing technique to understand the correct orientation of these peculiar fibres various terms were employed to describe them. Structurally, they possess a cell wall of uneven thickness and a lumen of irregular width. An examination of several such base forms has revealed that they can be distinguished from vascular fibres by their bizarre ends, larger transectional area, flat fibre-like bases, uneven and striated wall thickening and lumen of irregular width. By their profuse and sometimes crooked branching they do not approximate the form of a regular fibre as generally understood.

Thanks are due to Dr. K. Subramanyam for going through the manuscript.

47 G, Ballygunge Terrace, Calcutta-19. T. ANANDA RAO.
G. C. Bose Biological Research Unit (Bangabasi College), Calcutta-9, *April* 20, 1971. O. P. BHUPAL.

---

1. Francken, C. J. W., *Dissertation*, Utrecht, 1890, p. 1.
2. Solereder, H., *Systematic anatomy of the Dicotyledons*. Clarendon Press, Oxford, 1908, Vols. **1** and **2**.
3. Metcalf, C. R. and Chalk, L., *Anatomy of Dicotyledons* (Reprinted ed.), Clarendon Press, Oxford, 1957, Vols. **1** and **2**.
4. Rao, T. A., *Proc. Indian Acad. Sci.*, 1960, **52**, 27.
5. Nevlink L. I. (Jr.), *Jour. Arnold Arbor.*, 1961 *a*, **42**, 295.
6. —, *Ibid.*, 1961 *b*, **42**, 373.
7. Rao, A. N. and Wee Yeo Chin., *Flora B.*, 1966, **156**, 220.
8. Foster, A. S., *American J. Bot.*, 1950 *a*, **37**, 848.
9. —, *Bull. Torrey Bot. Club*, 1951, **78**, 382.
10. Webster, Grady L., *Jour. Arnold Arbor.*, 1956, **37**, 91.
11. Bhupal, O. P. (Personal communication).

RESPONSE OF GREENING PATHOGEN OF CITRUS TO CERTAIN TETRACYCLINE ANTIBIOTICS

GREENING disease of citrus has been found to be of very common occurrence in India[7-9]. Recently, mycoplasma like bodies have been found to be present in the phloem cells of greening affected sweet orange seedlings indicating that they may be the causal agent[5]. Mycoplasma like bodies associated with citrus greening disease have been isolated and cultured on artificial medium in this laboratory[2]. In September 1970, experiments were conducted at the Indian Agricultural Research Institute to test the effect of three tetracycline antibiotics, aureomycin (chlortetracycline hydrochloride), achromycin (tetracycline hydrochloride) and ledermycin (dimethyl chlortetracycline hydrochloride), Cyanamid India Ltd., products on the greening affected citrus plants. The results of these tests are presented in this paper.

Sixteen two-year-old-potted seedlings of sweet orange (*Citrus sinensis* Osbeck) infected with greening disease by grafting were used for the experiment. Sets of four plants were sprayed with each of the three antibiotics at 500 ppm till dripping stage and the fourth set of four plants was sprayed with water and served as control. Sprayings were repeated at weekly intervals for ten weeks.

After twelve weeks it was observed that three out of four plants under each of the treatments under achromycin and ledermycin spray showed recovery from greening symptoms whereas no effect was observed on plants sprayed with aureomycin and those sprayed with water. The recovery was mostly observed in the new growth which became completely green and devoid of stunting which is characteristic of severely greening affected plants. None of the control plants showed any changes in foliage and remained stunted with chlorotic leaves. The plants have remained in this condition during the course of observation for six months from the start of the experiment.

The diseases ascribed to mycoplasma have been shown in the past to respond to tetracyclin compounds[1,4,10]. Recently, the stubborn disease of citrus in the U.S.A. which is related to greening disease has also been suggested to be due to mycoplasma and the diseased plants have shown suppression of symptoms by tetracycline antibiotics[3]. Achromycin has also been found to have suppressive effect on symptoms of citrus greening disease in the Philippines[6]. Thus the tetracycline compounds offer a new field for investigations against the yellows type of virus diseases which have been attributed to mycoplasma like bodies.

Grateful thanks are due to the U.S. Department of Agriculture for providing funds under a PL. 480 project on Epiphytology of greening disease of citrus in India for carrying out these investigations.

Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi-12, *May* 5, 1971.
T. K. NARIANI.
S. P. RAYCHAUDHURI,
S. M. VISWANATH.

---

1. Davis, R. E., Whitcomb. R. F. and Steere, R. L., *Science*, 1968, **161**, 793.
2. Ghosh, S. K., Varma Anupam, Raychaudhuri, S. P. and Nariani, T. K., *Curr. Sci.*, 1971, **40**, 299.
3. Igwegbe, E. C. K. and Calavan, E. C., *Phytopathology*, 1970, **60**, 1525.
4. Ishie, T., Doi, Y., Yora, K. and Asuyama, H., *Ann. Phytopath. Soc. Japan*, 1967, **33**, 267.
5. Lafleche, D. and Bove, J. M., *Sciences* (Series D), 1970, **270**, 1915.
6. Martinez, A. L., Nora, D. M. and Armedilla, A. L., 1970, **54**, 1007.
7. Nariani, T. K. and Raychaudhuri, S. P., *Indian Phytopath.*, 1968, **21**, 343.
8. —, — and Bhalla, R. B., *Ibid.*, 1967, **20**, 1146.
9. —, — and Sharma, B. C., *Ibid.*, 1970, **23**, 141.
10. Raychaudhuri, S. P., Varma, A., Chenulu, V. V., Prakash, N. and Singh, S., "Association of Mycoplasma like bodies with little leaf of *Solanum melongena* L.," *Proceedings Intern. Cong. for Microbiology*, Mexico, 1970.

NICOTINAMIDE REQUIREMENT OF A STRAIN OF *FUSARIUM VASINFECTUM* ATK.*

DURING the course of a comparative *in vitro* study of eighteen different isolates of *Fusarium vasinfectum* Atk., obtained from different geographic regions of the world, it was noted that one of the strains, D1, made poor growth in synthetic medium. Addition of yeast extract, however, promoted the growth of this isolate (obtained from the Indian Agricultural Research Institute, New Delhi). This isolate was, therefore, tested for possible growth factor requirement.

The isolate was screened for vitamin deficiency using purified Richard's medium (Basal medium). Experiments were conducted in 100 ml Corning flasks, each with 20 ml of the basal medium. Vitamins added individually to the basal medium formed the different treatments; their levels being, thiamine 4 μg, biotin 0·1 μg, pyridoxine 4 μg, inositol 1 μg, para-aminobenzoic acid 4 μg, calcium pantothenate 4 μg, riboflavin 2 μg, choline chloride 4 μg, folic acid 4 μg. Flasks without added vitamins served as control. Six replicates were maintained for each treatment. Mycelial mat weights were taken after 14 days of incubation. The fungus was observed to show poor growth in the basal medium. In the presence of nicotinic acid, mycelial weight was nearer to that in basal medium with all vitamins. But the growth, however, was not as high as that in basal medium with yeast extract.

It is known that with some micro-organisms they are able to utilize nicotinamide better than nicotinic acid[1]. An experiment was, therefore, conducted supplying individually the same concentration of nicotinic acid and nicotinamide. Five replicates were maintained. The experiment was repeated. The results of the two experiments are shown in Table I and Fig. 1. The fungus showed optimal growth in the medium with nicotinamide similar to that seen with added yeast extract. Suboptimal growth was observed with nicotinic acid amendment. The optimal concentration of nicotinamide was found to be 1,000 μg per litre of the medium.

TABLE I

Mycelial dry weight (mg) of the strain D1 of F. vasinfectum *with and without added vitamin taken after 14 days of growth*

Expt.	Basal medium	Basal medium + nicotinic acid	Basal medium + nicotinamide	Basal medium + yeast extract
I	..	49	150	170
II	..	45	114	123

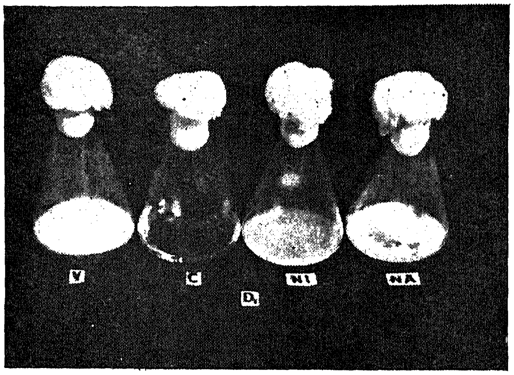


FIG. 1. showing the differential growth of D1 isolate of *F. vasinfectum* in Richards's medium (C), amended with yeast extract (Y), Nicotinic acid (NI), and nicotinamide (NA).

Instances of vitamin requirement in Fusaria have been reported in the case of a natural isolate of *Fusarium oxysporum* f.sp. *melonis*[2] and two induced mutants of *F. vasinfectum* Atk.[3] the former requiring biotin and the latter two showing partial requirement of nicotinic acid and para-aminobenzoic acid respectively. The present work reports the natural occurrence of a strain of *F. vasinfectum* which requires nicotinamide for growth.

I am thankful to Dr. R. Kalyanasundaram, Reader, Centre for Advanced Studies in Botany, for his guidance and for critical perusal of this manuscript. I thank Prof. T. S. Sadasivan, Director, for help and encouragement and Dr. S. Suryanarayanan for valuable suggestions. I am grateful to the University Grants Commission for the award of a Junior Research Fellowship.

Univ. Botany Lab., C. LAKSHMINARASIMHAM.
Madras-5, *April* 24, 1971.

---

* Memoir No. 124 from the Centre for Advanced Studies in Botany.

1. Lilly, V. G. and Barnett, H. L., *Physiology of the Fungi.* McGraw-Hill Book Company, Inc., New York. 1951.
2. Meyer, J. A. and Marite, H., *Nature, Lond.*, 1967, **216**, 70
3. Ramakrishna Rao, K. and Shanmugasundaram, E. R. B., *Experientia*, 1966 *a*, **22**, 138.

SCHIZOTHYRIOMA (PHACIDIALES), A NEW GENERIC RECORD TO INDIA

THIS is a rare and monotypic member of the apothecial Ascomycete and was collected by the writer at Khandala (Maharashtra) on dead wood during July 1969. The fungus was characterised by a discoid ascocarp, unitunicate asci in palisade-like layer and opening by a wide cleft characteristic of the fruit bodies of the Phacidiales. Being a new generic record to India, a comparative study was made between the present collection and the type species, *Schizothyrioma ptarmicae* (Desm) V. Hoehn. which revealed it to be significantly distinct from the type in respect of dimensions of ascocarps, asci and ascospores (Table I).

TABLE I

Comparison between writer's collection and the type species

Species	Ascocarp	Asci	Ascospores	Interascal filaments
S. ptarmicæ (Desm) Hoehn. (Type species)	200 μ–1 mm × 70–120 μ	46– 50 × 6– 8 μ	12–15 × 5–6 μ	Septate
Schizothyrioma sp. (Khandala collection)	200–500 μ or more (diam.)	80–100 × 8–10 μ	18–24 × 4–5 μ	Non-septate

The present collection is, therefore, offered as new to science with Latin diagnosis.

Schizothyrioma indica sp. nov. Pande (Fig. 1).

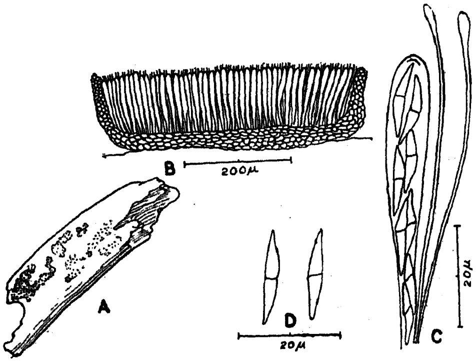


FIG. 1. (A) Habit. (B) Section of the assocarp. (C) Ascus and interascal threads. (D) Ascospores.

Ascoma minutus, superficialis, disciformis, nigra, diametro 200–500 μ vel plura; orifico late fissus. Asci plures, cylindracei, parallelus, in basal strata, octospori, unitunicati, pachypari; metientes 80–100 × 8–10 μ. Ascosporae fusiformae, bicellularae, hyalinae: 18–24 × 4–5 μ. Filis plures continuei, hyalinae, discretae et bulbosi extremis.

In culmis emortuis, Leg. Alaka Pande; ad Khandala, Mense Juli, Anni 1969, M.A.C.S. Herb. No. 1225 (Typus).

Clements and Shear (1957) placed the genus *Schizothyrium* Desm. under Hemisphaeriales as well as Phacidiales and Hysteriales. The author's collection obviously has no relationship to Hemisphaeriales on the basis of the disc-shaped ascocarps opening with a wide irregular cleft and unitunicate asci.

Muller and Arx (1952) placed this genus under Schizothyriaceae of Dothiorales. According to them, the species of this genus have been variously described as having unitunicate as well as bitunicate asci necessitating their segregation under their proper taxonomic position. The species *Schizothyrium ptarmicae* (DC) Desm. with unitunicate asci properly belongs to the genus *Schizothyrioma* Hoehn. with *Schizothyrioma ptarmicae* (Desm.) Hoechnel as the type species (von Hoehnel, 1917), having relationships with the Phacidiales (Ascohymeniales).

This is the second species of the genus which constitutes a new generic record to the Fungi of India.

The author is grateful to Prof. M. N. Kamat for his guidance and encouragement, to the Director, M.A.C.S., for laboratory facilities, and to the C.S.I.R., for the award of a Senior Research Fellowship.

M.A.C.S., Research Institute,
Poona-4, India, *June* 11, 1971.

MRS. ALAKA PANDE.

---

1. Clements, F. E and Shear, C. L., *Genera of Fungi*, Hafner Publishing Co., New York, 1957.
2. Muller, E. and Arx, J. A. V., *Die Gattungen der amerosporen Pyrenomyceten*, 1952.
3. von. Hoehnel, F., 'Mykologische Fragmente," *Ann. Mycol.*, 1917 **15**, 293.

OCCURRENCE OF MONOSPORIC AND BISPORIC EMBRYO-SACS IN *DENDROBIUM MACROSTACHYUM*, LINDL.

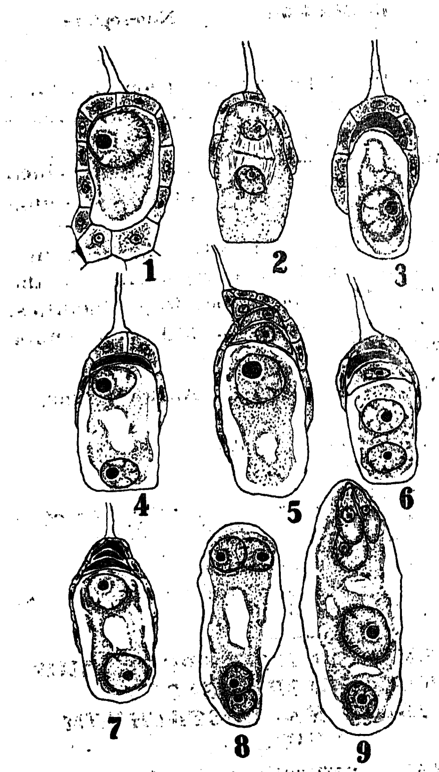
EMBRYOLOGICAL investigations in Orchidaceae are of great interest because of the numerous variations seen in the embryo-sac development. Earlier literature includes the contributions of Schnarf, Swamy and others[1-4].

The present investigation deals with some aspects of embryo-sac development in *Dendrobium macrostachyum*, Lindl. The plant is an epiphytic herb having elongate leafy stems 1–2 feet in length. Leaves are sessile.

Material for the present work was collected from plants grown in our garden. Flower buds were fixed in F.A.A. and after customary processing and paraffin embedding sections were cut at 8–10 μ and stained with Heidenhain's iron alum haematoxylin and counterstained with eosin.

The ovary is inferior, tricarpellary, syncarpous, unilocular with numerous minute anatropous ovules on parietal placenta. The ovules arise as small protruberances on the placental ridges. Unequal development on the sides makes the ovules anatropous. The ovules are tenuinucellate and bitegmic.

A hypodermal archesporial cell enlarges and directly functions as the megaspore mother cell (Figs. 1 and 2). This develops into either Polygonum or Allium types of embryo-sac.



FIGS. 1–9. Fig. 1. M.M.C. Figs. 2–4. L.S. o ovules showing bisporic development. Figs. 5–6 Tetrads. Figs. 7–8, 2 and 4 nucleate embryo-sacs. Fig. 9. Organised embryo-sac. (All figures × 1,000.)

In the majority of ovules the megaspore mother cell undergoes reduction division to form 2 cells of 2 nuclei each, where the upper dyad degenerates and only the lower dyad contributes to the development of embryo-sac. Consequently the development conforms to Allium type (Figs. 2–4).

In about 3% of the ovules observed the development of embryo-sac conforms to Polygonum type (Figs. 5–9). The mature embryo-sac however is 5-nucleate. This is due to the non-division of the 2 chalazal nuclei at the 4 nucleate stage of the embryo-sac. It is interesting to note that these two types of embryo-sac development can take place in the adjacent ovules of the same ovary.

My thanks are due to Rev. Fr. Menezes, Principal and Prof. S. Shamanna for their encouragement and to G. Shivaramiah for his valuable help.

Department of Botany, S. SUNDARA RAJAN.
St. Joseph's College,
Bangalore-1, India, *April* 5, 1971.

---

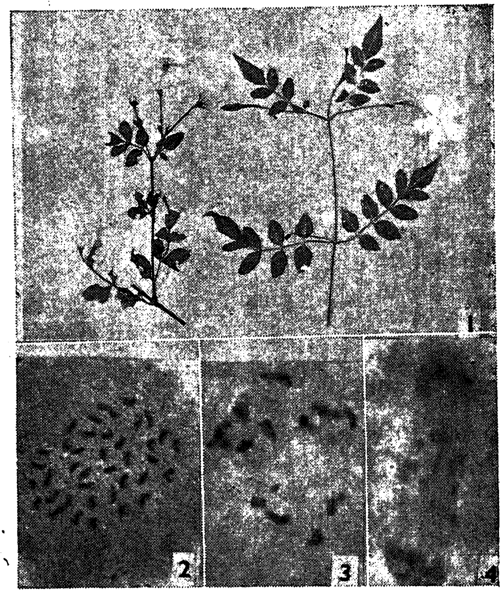
1. Maheswari, P. and Narayanaswamy, S., *Jour. Linn. Soc.*, 1952, **53**, 355, 474.
2. Schnarf, K., *Vergleichende Embryologie der Angiospermen*, Berlin.
3. Swamy, B. G. L., *Amer. Midl. Nat.*, 1949 *a*, **41**, 184.
4. Swaminathan, D., *Curr. Sci.*, 1967, **36** (14), 384.

A STUDY OF TRIPLOID *JASMINUM GRANDIFLORUM* L.

Jasminum grandiflorum L. is considered to be a native of N.W. Himalayas occurring at an altitude of 3,000–9,000 feet[1]. It is one of the three species of *Jasminum* commercially exploited for the extraction of essential oil contained in the flowers, and is the chief source of the commercial perfume in Europe and Mediterranean countries. Cytology of this species has been reported by several workers[2-6]. The chromosome number reported is 26 in each case.

Among our collections, two slightly differing horticultural types of *J. grandiflorum* were noticed and their chromosome counts were made from well-spread metaphase plates of root tips produced from stem cuttings. The material was pretreated with 0·002 M 8-hydroxyquinoline and squashed in aceto-orcein following the usual technique. For meiosis the chromosomes were studied from PMC by fixing the buds in Carnoy's for 24 hrs and smearing in propiano-carmine. Standard procedures[7] were adopted for the estimation of oil content. The flowers were collected early in the morning in bright weather for this purpose.

The cytological studies revealed that one group of plants is diploid with $2n = 26$ and the other is triploid with $2n = 39$ chromosomes. Even though it is difficult to distinguish triploids from diploids by casual observation (Fig. 1) they can be recognised by an overall reduction in the leaf length with a reduction in stomatal frequency and flower size. The number of leaflets varies from 5–7 in triploid and 7–9 in diploid. An increase in stomatal size and weight of the flower has been observed in the triploid over the diploid.



FIGS. 1–4. Fig. 1. Comparative morphological features of triploid and diploid *J grandiflorum.* Fig. 2. Mitotic metaphase chromosomes of triploid. Fig. 3. Meiotic metaphase chromosomes of triploid showing association into tri–, bi– and univalents. Fig. 4. A_1 in triploid showing laggards.

39 chromosomes are observed (Fig. 2) in root tip mitosis of triploid, and the nucleolus does not persist as has been reported by Raman[5]. Meiosis is found to be normal in diploid but in the triploid associations from univalents to trivalents are observed (Table I, Fig. 3) resulting in various meiotic abnormalities (Fig. 4). The pollen sterility is high even in diploids (78·6%) though not to the extent as it is in triploids (95%). No fruit formation is observed in either case.

TABLE I

Type of chromosomal association in M_1 of triploid Jasminum

	Trivalents	Frequency of Bivalents	Frequency of Univalents	No. of PMC in which observed
	2	13	7	1
	3	11	8	1
	4	10	7	1
	5	10	4	1
	5	9	6	1
	5	7	10	1
	7	7	4	5
	7	8	2	5
	7	4	10	1
	8	6	3	4
	8	5	5	1
	9	4	4	1
	9	5	2	1
	10	3	3	1
Mean	6·76	7·2	4·32	Total 25

In the diploid the percentage of concrete (based on petal weight) is 0·54 of which 70·8% is absolute while in the triploid the concrete percentage is 0·43 with an absolute content of 66·7%. There is thus, a reduction in the triploid over the diploid for both total concrete as well as the percentage of absolute in it.

This observation is the first case of triploidy in *J. grandiflorum.* No clear proof is available regarding the nature of the triploid. Attempts made by us to hybridize *J. grandiflorum* with other garden species, which could possibly have thrown some light on the nature of the present triploid, have not succeeded.

The authors are thankful to Dr. L. B. Singh, Director, National Botanic Gardens, for his interest in the problem and to Dr. Peter S. Green, Kew Gardens, for help with the identification.

National Botanic Gardens, Lucknow, *May* 7, 1971.
A. S. MURTY.
K. R. KHANNA.

---

1. *The Wealth of India, Raw Materials*, Council of Scientific and Industrial Research, 1959.
2. Bowden, W. M., *Amer. J. Bot.*, 1940, **27**, 357.
3. Krishnaswamy, N. and Raman, V. S., *J. Indian bot. Soc.*, 1948, **27**, 77.
4. Dutt, M., *Sci. & Cult.*, 1952, **17**, 527.
5. Raman, V. S., *Cytologia*, 1955, **20**, 19.
6. Sharma, A. K. and Sharma, A., *Ibid.*, 1958, **23**, **172**.
7. Guenther. E., *The Essential Oils*, D. Von Nostrand Co., Inc., New York, 1949.

STALKED OVARY : A NEW MUTANT IN BARLEY INDUCED BY EMS

ABSTRACT

A new mutant, stalked ovary, was induced by EMS treatment in C 164 barley. This mutant trait was inherited as a single recessive gene designated as *so*. The mutant is characterised by the ovary having a long stalk and the efilamentous anthers borne around the base of the ovary.

THIS study deals with the induction and genetic analysis of a stalked-ovary mutant in barley.

Dry seeds of diploid hexastichous barley (*Hordeum vulgare* L., cv C 164) were treated with various doses of EMS, ^{60}Co gamma rays, ^{32}P and ^{35}S, as reported by Sethi and Gill (1969). The M_2 generation consisting of 6820 M_1 spike-progenies, was studied for various morphological and cytological abnormalities. Out of these, one progeny from 0·15% EMS treatment threw out 4 stalked-ovary mutants and 15 normal plants. The progenies of all the normal sib plants were raised in 1968–69 to find out the mode of inheritance of the trait under study. The progeny of the mutant was also grown. For meiotic studies of the mutant, anthers were fixed in acetic alcohol (1 : 3) and smeared in acetocarmine. Pollen stainability was studied by the aceto-carmine glycerine method.

Out of 6820 M_1 spike-progenies studied in M_2, 1761 segregated for 173 types of mutations, including the one for the stalked-ovary mutations which is under study.

Morphology.—The mutant trait was characterized by the ovary having about 5 mm long stalk with the efilamentous anthers around the base of the ovary (Fig. 1). The character was expressed in the florets of only the four lateral rows whereas those of the central rows of the spike were normal. Grain development occurred only in florets of the central rows. The mutant in other respects was normal and yielded about 40% of the control.

Cytology.—The mutant was meiotically normal with 7 bivalents at diakinesis followed by regular metaphase and anaphase stages. The pollen grains of the mutant were fertile as indexed by their stainability with aceto-carmine. This showed that, at least, no gross chromosome aberration was associated with the mutant trait.

Genetics.—Four out of the 15 M_3 progenies segregated for the trait under study and threw out 24 mutants and 94 normal plants. This segregation conforms to the expected 3 : 1 ratio (χ^2 1·15 ; 0·30 P 0·25) suggesting that the mutant trait is monogenic recessive. The first appearance of the mutant in the M_2 generation and that too in the segregation ratio of 21% (4 mutants and 15 normal plants) also supports the same hypothesis. Also, the progeny of the mutant bred true to the type. The recessive allele may be designated as so.

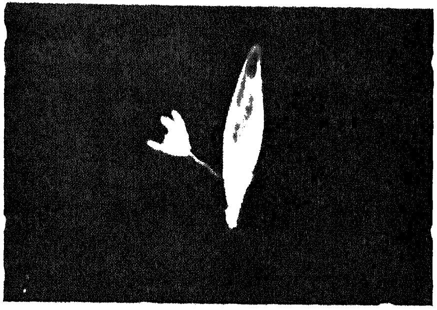


FIG. 1. The ovary having a long stalk and the filamentless anthers borne at the base of the ovary.

The stalked-ovary phenotype is interesting because it has not been reported earlier in any species of Gramineae. This trait may find a significant place in genetic research.

Dept. of Plant Breeding, **GURDIP SINGH SETHI.**
Punjab Agri. Univ., **KHEM SINGH GILL.**
Ludhiana, India, *May* 28, 1971.

---

1. Sethi, G. S. and Gill, K. S., "Doubling-tendency morphological change induced by different mutagens in barely," *Rad. Bot.*, 1969, **9**, 415.

MAMMALIAN TOXICITY OF ERGOT OF BAJRA

BAJRA (*Pennisetum typhoides*, B & S) is one of the staple food crops in India and it is severely infected by the ergot pathogen, *Claviceps microcephala* (Wallr.) Tul. The grains are often contaminated with the ergots. While mammalian toxicity of ergots from rye[1] is well known, the toxic effect of the ergot of *C. microcephala* from bajra is not known. In the present studies the mammalian toxicity of the ergots from bajra is reported.

Guinea pigs of equal age and weight were fed with different doses of fully matured ergots daily. The sclerotia were mixed with the millet grains and fed to the pigs. Pigs fed with the grains alone were kept as control and large number of animals were kept for replications. After 10 days, the weight of the guinea pigs was recorded and then the guinea pigs were killed and dissected out and changes in various organs were recorded. Heart, kidneys and reproductive organs did not show any change due to the ergot feeding. But liver and lungs seemed to be much affected (Fig. 1 and Table I).

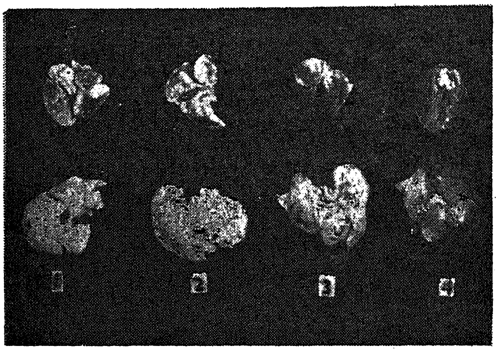


FIG. 1. Toxicity of bajra ergots to lungs and liver of guinea pigs. Top row: Lungs. Bottom row: Liver. 1. Control. 2. 0 5 g ergots/day. 3. 2·0 g ergots/day. 4. 3·0 g ergots/day.

TABLE I

Toxicity of Bajra ergots to guinea pigs

Dosage of ergots fed to guiena pigs	Percentage increase (+) or decrease (−) in body weight of guinea pigs over the initial weight	Colour of the liver	Colour of the lungs
Control ..	+ 9·2	Light red	Dark red
0·5 g/day	−17·8	Light brown	Scattered black necrotic spots
2·0 g/day	−19·5	Dark brown	Complete black
3·0 g/day	−29·0	,,	,,

The presence of various toxic alkaloids in the ergots was assessed by paper chromatography[2]. Three alkaloids, ergometrine, ergotamine and ergokryptine were detected. The quantity of total and water-soluble alkaloids content of the ergots was estimated by using DU Beckman spectrophotometer[3]. The quantity of alkaloids was assessed at different stages of the ergot development on the earhead by spray inoculating the conidial suspension of the pathogen on the bajra earhead (Table II).

The results indicated that well-matured ergots contained more alkaloids.

Ergots of *C. purpurea*[4], *C. paspali*[5] and *C. fusiformis*[6] have been reported to be poisonous to livestock. Shone *et al.*[7] reported the presence of ergotoxine, ergotamine and ergometrine in the ergots of *C. fusiformis* from bajra. Riggs *et al.*[8] observed ergometrine, ergometrinine, ergotamine, ergocornine and ergocristinine, in rye ergots. In the present studies, ergometrine, ergotamine and ergokryptine have been detected in *C. microcephala* ergots.

TABLE II

Total and water-soluble alkaloids content in bajra ergots

Days after spray inoculation	Percentage of alkaloids in the ergots on dry weight basis	
	Total alkaloids	Water-soluble alkaloids
7	0·081	0·037
10	0·125	0·062
15	0·153	0·081
20	0·275	0·087
25	0·506	0·097
30	0·625	0·156

Shinde and Bhide[9] observed 0·42% of total alkaloids in *C. microcephala* ergots while Mantle[6] reported 0·32% of total alkaloids in *C. fusiformis* ergots and Bekesy[10] observed 1·0% of total alkaloids in *C. purpurea* ergots. The present studies revealed that the alkaloids content of *C. microcephala* ergots varied according to the stages of ergot development and a maximum of 0·625% alkaloids was observed in the advanced stages of sclerotial development. *C. purpurea* sclerotia contained only 0·01% water-soluble alkaloids[11] while *C. microcephala* sclerotia were observed to contain upto the maximum of 0·156% water-soluble alkaloids.

Division of Plant Pathology, — J. KANNAIYAN.
Agricultural College and — P. VIDHYASEKARAN.
Research Institute, — T. K. KANDASWAMY.
Coimbatore-3, *June* 7, 1971.

---

1. Emmons, C. W., *Mycologia*, 1961, **53**, 1.
2. Forster, G. E., Mac Donald, J. and Jones, T. S. G., *J. Pharm. Pharmacol.*, 1949, **1**, 802.
3. Smith, R. G., *J. Am. Pharm. Ass. Sci. Ed.*, **1947**, **36**, **321**.
4. Tanda, S., Tadakuma, Y. and Matsunami, Y., *J. Agric. Sci. (Tokyo)*, 1968, **13**, 61.
5. Steyn, D. G., *Fmg. S. Afr.*, 1940, **15**, 340.
6. Mantle, P. G., *Proc. Roy. Soc.*, 1968, **170 B**, 423.
7. Shone, D. K., Philip, J. R. and Christie, S. G. J., *Vet. Res.*, 1959, **71**, 129.
8. Riggs, R., Henson. L. and Chapman, R. A., *Phytopathology*, 1968, **58**, 54.
9. Shinde, P. A. and Bhide, V. P., *Curr. Sci.*, **1968**, **27**, **499**.
10. Bekesy, N. V., *Biochem. J.*, 1940, **102**, **187**.
11. Alexander, T. G. and Banes, D., *J. Pharm. Sci.*, 1961, **50**, **201**.

REVIEWS AND NOTICES OF BOOKS

Hydrogen Bonding. By S. N. Virogradov and R. H. Linnell. (Published by Van Nostrand Reinhold Company, 450, West 33rd Street, New York, N.Y. 10001), 1971. Pp. xi + 319. Price $ 9.50.

This is an excellent book on "Hydrogen Bonding", compact in size, but comprehensive in contents.

Since the first explicit recognition of the existence of hydrogen bonding by Latimer and Rodebush in 1920, research papers that have appeared on hydrogen bonding are myriad, and book publications on it, like monographs, proceedings of conferences, seminars and symposia, many. Still the field is growing rapidly and literature continues to flow. However, conspicuously lacking is a book on hydrogen bonding suitable for under-graduate students and non-specialists. The present publication just meets this end, and that too, in an extremely useful manner.

The authors deal with all aspects of hydrogen bonding, its nature, its manifestations, its importance in biological macromolecules, cellular organization, and pharmacological action. The treatment is simple, systematic and readable. The coverage is comprehensive as will be evident from the following chapter headings: Molecular Interactions and Chemical Bonds; Physical Properties of Hydrogen Bonded Systems; Spectroscopic Manifestations of Hydrogen Bonding; Proton Magnetic Resonance and Electronic Spectroscopy; Thermodynamics of Hydrogen Bondings; Models of Hydrogen Bonding and Strong Hydrogen Bonds; Hydrogen Bonds in Solids; Hydrogen Bonding in Water, Ice, and Aqueous Solutions; The Hydrogen Bond in Biological Materials; and Special Topics in Hydrogen Bonding.

Some twenty problems, based on data taken from published papers, and their solutions appear as an appendix to the book.

The book can be recommended to undergraduate and graduate students of chemistry, biochemistry and life sciences. Non-specialists who wish to have an overall view of the subject will find a perusal of the book very rewarding.

A. S. G.

Analytical Calorimetry (Vol. 2). Edited by R. S. Porter and J. F. Johnson. (Plenum Pub. Corpn. 114, Fifth Avenue, New York 10011, N.Y.), 1971. Pp. xvi + 460. Price $ 19.50.

The first volume in this series was published in 1968, the present volume contains the proceedings of the American Chemical Society Symposium of September 14 and 15, 1970 held in Chicago. The 35 papers contributed by 66 authors represent the major significant advances that have been made in the two years in the field of analytical chemistry.

Thermoanalytical techniques such as differential thermal analysis, differential scanning calorimetry. thermogravimetry and thermal depolarization have been responsible for these advances, and they are all discussed in these papers. The subjects covered include studies on polymers, copolymers, catalytic reductions, kinetics of dissolution, measurement of polymerization heats and curing of thermosetting resins. There is also a paper on stored energy measurements in Apollo 11 lunar samples by DTA.

A. S. G.

Thermophysical Properties of Matter: The TPRC Data Series. Editor: Y. S. Touloukian, Director, Thermophysical Properties Research Centre, Purdue Industrial Research Park, 2595, Yeager Road, West Lafayette, Indiana 47906. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011, N.S.A.).

Thermophysical Properties of Matter, the TPRC Data Series, is the culmination of twelve years of pioneering effort in the generation of tables of numerical data on materials of interest for science and technology. It constitutes the restructuring, accompanied by extensive revision and expansion of coverage, of the original *TPRC Data Book*, first released in 1960 in loose-leaf format, and followed up by biannual supplements, the last of which came out in December 1966.

Over the years the *Data Book* loose-leaf format has grown in size and become somewhat unwieldy too in its maintenance by the user. Recently, a decision was taken by the TPRC and IFI/Plenum Data Corporation to issue the complete *Data Book* in conventional bound volumes, and the present volumes are the outcome of this decision.

This massive, well-planned and carefully brought out series consists of 13 independent volumes. The initial ten volumes will be published in 1970, and the remaining three by 1972. The volumes in this series are as follows :

Thermal Conductivity—Vol. 1—Metallic Elements and Alloys ; Vol. 2—Non-metallic Solids ; Vol. 3—Non-metallic Liquids and Gases (Pp. 531. Price $ 55.00).

Specific Heat—Vol. 4—Metallic Elements and Alloys (pp. 750, Price $ 65.00) ; Vol. 5—Non-metallic Soilds (Pp. 1649. Price $ 100.00) ; Vol. 6—Non-metallic Liquids and Gases (Pp. 312. Price $ 40.00).

Thermal Radiative Properties—Vol. 7—Metallic Elements and Alloys (Pp. 1529. Price $ 100.00) ; Vol. 8—Non-metallic Solids ; Vol. 9—Coatings.

Thermal Diffusivity (Vol. 10).

Viscosity (Vol. 11).

Thermal Expansion—Vol. 12—Metallic Elements and Alloys ; and Vol. 13—Non-metallic Solids.

The coverage of the specific thermophysical properties represented by this series constitutes the most comprehensive and authoritative collection of numerical data of its kind for science and technology.

Each volume is a self-contained entity and provides at the beginning a basic theoretical treatment and a brief review of established experimental techniques. The Numerical data which form the core of each volume is presented in both graphical and tabular format. At the end of each volume is the very useful material index which will enable the reader to locate the particular material whose properties he seeks, be it under the name of an element, alloy, mixture composition, trade name, synonym, etc.

The TPRC Data Series constitutes a permanent and valuable contribution to science and technology and should form a necessary acquisition to all scientific and technological libraries and laboratories. In them a wealth of data heretofore unknown or not readily available has been made accessible to engineers and scientists.

The TPRC/IFI Plenum Data Corporation are extending facilities to Owners of the *Data Series* volume to receive annual listing of corrigenda during the life of this edition.

A. S. G.

ANNOUNCEMENTS

The Indian Academy of Sciences

The 37th Annual Meeting of the Indian Academy of Sciences will be held at the Raman Research Institute, Bangalore, on 7-9 November 1971.

Programme : 7th November 1971 (Evening) Inaugural Session : Presidential Address by Prof. T. S. Sadasivan, Acting President ; 8th November 1971 (Forenoon and afternoon) Symposium of papers on "Some Scientific Ideas Proposed by Sir C. V. Raman" ; (Evening) Lecture on "Professor Raman and his work" ; 9th November 1971 (Forenoon) Physical Sciences : Symposium of papers on "Logic, Pattern Recognition, etc." ; (Afternoon) Symposium of papers on "Life Sciences".

Award of Research Degrees

The M.S. University of Baroda has awarded the Ph.D. degree in Microbiology to Shri Jawaharlal Raina ; Ph.D. degree in Botany to Shri Virendrakumar Punjalal Fadia ; Ph.D. degree in Pharmacology to Shri Om Parkash Sethi.

Sri Venkateswara University has awarded the Ph.D. degree in Chemistry to Shri R. Raghava Naidu.

Books Received

Symmetry in Chemistry. By H. H. Jaffe, Milton Orchin. (Wiley Eastern Private Ltd., J. 41, South Extension 1, New Delhi-49), 1971. Pp. x + 191. Price Rs. 13·50.

Elementary Solid-State Physics. By R. Ramaswamy. (Mrs. Lakshmi Ramaswamy, C/37, Thirunagar, Madurai-6), 1971. Pp. 254. Price Rs. 8·00.

Molecular-Genetic Mechanisms of Development. By Z. A. Medivedev. (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xiv + 418. Price $ 25.00.

Photochemistry of Macromolecules. Edited by R. F. Reinisch. (Plenum Pub. Corpn., 114, Fifth Vvenue, New York, N.Y. 10011), 1970. Pp. x + 229. Price $ 10.00.

Physiological Effects of Noise. Edited by B. L. Welch and A. S. Welch: (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011); 1970. Pp. xviii + 365. Price $ 15.00.

Single Agents in Cancer Chemotherapy. By R. B. Livingston and S. K. Carter: (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. x + 405. Price $ 20.00.

3084-71. **Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, L.P.T., Superintendent, at The Bangalore Press, Bangalore-18.**

UNIVERSAL STABILITY OF THE LAMINAR DISPERSION OF SOLUTE IN A POROUS MEDIUM

N. RUDRAIAH AND PRABHAMANI PATIL

Department of Mathematics (Post-Graduate Studies), Visvesvaraya College of Engineering, Bangalore-1, India

ABSTRACT

A universal stability limit for the laminar dispersion of a solute in a porous medium is obtained in terms of a Reynolds number and a Rayleigh number. This stability limit is improved using the techniques of calculus of variation. By increasing the Reynolds number R_o towards unity, we find that the stability region is decreased by decreasing the Rayleigh number R_a for the solvent.

1. INTRODUCTION

THE effects of buoyancy forces caused by a density difference between the solute and the solvent, when the solute is injected into the solvent through a porous medium, on the stability of concentrated flow is of particular interest in dye industry. In such circumstances to study the stability, one has to take into account the natural convection within the diffusion cell. In practice, such a convection would arise from either a thermal gradient, a solute gradient or a combination of these. In the present problem we are concerned only with the convection due to a solute gradient. The physical model we consider is that the solute is injected into the solvent, where the density of the solute is different from that of the solvent, so that, the buoyancy forces associated with the density gradients set up the secondary flows and the solute gives rise to definite dynamical effects which will be absent in the case of no buoyancy effect (*i.e.*, the solute and the solvent have the same density). Recently Emim Erdogan and Chatwin (1967) have studied the steady flow of a solvent in a tube and have correlated their theory with the experimental work of Reejhsinghani *et al.* (1966). These theoretical and experimental works were based on the nature of the steady flow and the stability of that flow has not been given much attention. The purpose of this paper is to study the universal stability, namely, a stability for motions subject to arbitrary non-linear disturbances of the flow of solvent in a porous medium into which a solute of different density is injected.

2. UNIVERSAL STABILITY ANALYSIS

We assume that the flow of solvent and the concentration factor C, in a bounded region V (t) with the boundary S, are governed by the following system of equations:

Darcy's law:

$$\rho\left[\frac{\partial \vec{q}}{\partial t} + (\vec{q}.\nabla)\vec{q}\right] = -\nabla p - \rho g/k\,\vec{q} + \rho\vec{g}. \qquad (1)$$

Fick's law:

$$\frac{\partial C}{\partial t} + (\vec{q}.\nabla)C = D\nabla^2 C. \qquad (2)$$

Equation of continuity:

$$\frac{\partial \rho}{\partial t} + (\vec{q}.\nabla)\rho + \rho\nabla.\vec{q} = 0 \qquad (3)$$

where $\vec{q}$ is the fluid velocity, ρ is the density, p is the pressure, k is the permeability of the porous medium, g is the acceleration due to gravity and D is the diffusion coefficient. The boundary conditions are:

$$\vec{q}.\hat{n} = 0; \quad \frac{\partial C}{\partial n} + \sigma C = 0 \text{ on S} \qquad (4)$$

where σ is a continuous function of position and $\hat{n}$ is the outward unit normal vector.

The equations (1) to (3) under the Boussinesq approximation, *i.e.*, the density ρ is replaced by a constant ρ_0 everywhere except in the last term of equation (1) and using $\rho = \rho_0[1 + \alpha C]$ where α is the coefficient of volume expansion, become

$$\frac{\partial \vec{q}}{\partial t} + (\vec{q}.\nabla)\vec{q}$$
$$= -\frac{1}{\rho_0}\nabla p - \frac{g}{k}\vec{q} + [1 + \alpha C]\vec{g} \qquad (1\,a)$$

$$\frac{\partial C}{\partial t} + (\vec{q}.\nabla)C = D\nabla^2 C \qquad (2\,a)$$

$$\nabla.\vec{q} = 0. \qquad (3\,a)$$

The basic motion $(\vec{q}, C, p)$ at time $t=0$, is altered to $\vec{q}^{\,*} = \vec{q} + \vec{u}$; $C^* = C + \theta$; $p^* = p + P$, where both the basic and altered flows satisfy the same basic equations (1) to

(3) and the same boundary conditions (4). Our aim is to determine whether the altered flow will approach the basic flow as $t \to \infty$. This we determine by using the energy principle as developed by Joseph (1966). Obtaining the difference equations by subtracting the equations for the basic flow from those of the altered flow and multiplying the resulting Darcy's law and Fick's law scalarly by $\vec{u}$ and θ respectively we obtain the energy equations.

$$\frac{dK_1}{dt} + \frac{2g}{k} K_1 = -\langle \vec{u}.\vec{E}.\vec{u} - \alpha\vec{g}.u\theta\rangle \tag{5}$$

$$\frac{dK_2}{dt} = -\langle \vec{u}.\nabla C\theta + D\nabla\theta.\nabla\theta\rangle - D\langle\sigma\theta^2\rangle' \tag{6}$$

where $\vec{E}$ is the basic strain rate tensor,

$K_1 = \langle \frac{1}{2} u^2 \rangle$ is the Kinetic energy,

$K_2 = \langle \frac{1}{2} \theta^2 \rangle$ is the concentration energy.

$\langle$ denotes the volume integral over V and $\langle\,\rangle'$ denotes the surface integral over S.

Defining $-m$ as the least eigenvalue of E, $\beta = \max. \ |\nabla C|$, applying the Schwartz's inequality and using the conditions

$$\vec{u}\ .\ \hat{n} = 0; \frac{\partial\theta}{\partial n} + \sigma\theta = 0; \nabla \cdot \vec{u} = 0 \tag{7}$$

we obtain

$$\frac{1}{g\alpha}\frac{d\hat{K}_1}{dt} + \frac{(1 - Re)}{k\alpha}\hat{K}_1 - \hat{K}_2 \leqslant 0 \tag{8}$$

$$\frac{1}{\beta}\frac{d\hat{K}_2}{dt} + \frac{\Sigma D}{\beta d^2}\hat{K}_2 - \hat{K}_1 \leqslant 0 \tag{9}$$

where

$$K_1 = \hat{K}_1^2;\ K_2 = \hat{K}_2^2;\ Re = \frac{mk}{g} \text{ and } \Sigma$$

is such that

$$\langle\nabla\theta \cdot \nabla\theta\rangle + \langle\sigma\theta^2\rangle' \geqslant \frac{2\Sigma}{d^2} K_2.$$

We note that

$$X = \left(\mu + \frac{\Sigma D}{d^2}\right)\exp.(-\mu t)$$

and

$$Y = \beta\exp.(-\mu t)$$

where

$$\mu = -\frac{1}{2}\left[\frac{\Sigma D}{d^2} + \frac{g}{k}(1 - Re)\right] + \frac{1}{2}\left[\left\{\frac{\Sigma D}{d^2} + \frac{g}{k}(1 - Re)\right\}^2 - \frac{4Dg}{d^2 k}\{\Sigma(1 - Re) - Ra\}\right]^{\frac{1}{2}}. \tag{10}$$

$R_a = \alpha\beta d^2 k/D$ is the Rayleigh number for the solvent, satisfy the differential equations

$$-\frac{1}{g\alpha}\frac{dX}{dt} + \frac{(1 - Re)}{k\alpha}X - Y = 0 \tag{11}$$

$$-\frac{1}{\beta}\frac{dy}{dt} + \frac{\Sigma D}{\beta d^2}Y - X = 0 \tag{12}$$

and X and Y are both positive.

Multiplying equation (8) by X and (11) by $\hat{K}_1$ and then subtracting, we obtain

$$\frac{1}{g\alpha}\frac{d}{dt}(\hat{K}_1 X) - \hat{K}_2 X + \hat{K}_1 Y \leqslant 0. \tag{13}$$

By a similar process from equations (9) and (12) we obtain

$$\frac{1}{\beta}\frac{d}{dt}(\hat{K}_2 Y) - \hat{K}_1 Y + \hat{K}_2 X \leqslant 0. \tag{14}$$

Adding (13) and (14) and integrating it from 0 to t, we get

$$\left(\mu + \frac{\Sigma D}{d^2}\right) K_1^{\frac{1}{2}} + g\alpha(K_2)^{\frac{1}{2}} \leqslant \left[\left(\mu + \frac{\Sigma D}{d^2}\right)(K_{10})^{\frac{1}{2}} + g\alpha(K_{20})^{\frac{1}{2}}\right]\exp.(\mu t)$$

where $(\mu + \Sigma D/d^2) > 0$, K_{10} and K_{20} are the initial values of K_1 and K_2. $K_1 \to 0$ and $K_2 \to 0$ as $t \to \infty$ if $\mu < 0$. From equation (10) it follows that $\mu < 0$ if $R < \Sigma\ (1 - R)$. Hence the condition for universal stability is

$$0 \leqslant Ra \leqslant \Sigma(1 - Re). \tag{15}$$

The number Σ will depend on the geometrical configuration, *i.e.*, $\Sigma = 3$ for a spherical geometry, $\Sigma = 1$ for a channel flow.

The limit (15) can be further improved using the techniques of the calculus of variation. For this, equations (5) and (6) are re-written in the form

$$\frac{d}{d\tau}(K_1 + \lambda Pr\, K_2) = -[Ra^{\frac{1}{2}}(I_1 + \lambda I_2) + (I_3 + \lambda I_4)] \tag{16}$$

where

$$I_1 = \langle\mu_1\vec{v}\cdot\vec{F}\cdot\vec{v} + \hat{k}\cdot\vec{v}\theta\rangle;\quad I_2 = \langle\vec{v}\cdot\nabla\psi\theta\rangle;$$

$$I_3 = \langle v^2\rangle;\quad I_4 = \langle\nabla\theta\cdot\nabla\theta\rangle + \langle\sigma\theta^2\rangle'.$$

$$\left(\frac{\alpha Dk}{\beta d^2}\right)^{\frac{1}{2}}\vec{v} = \vec{u};\quad m\vec{F} = \vec{E};\quad \beta d\psi = C;\quad \tau = \frac{gt}{k};$$

$$\vec{g} = -g\hat{k};\ \mu_1 = \frac{Re}{\sqrt{Ra}};\ Pr = \frac{gd^2}{kD}.$$

The motion is stable if $d/d\tau\ (K_1 + \lambda\, p\ K_2) < 0$, which is possible only when

$$Ra^{\frac{1}{2}}(I_1 + \lambda I_2) + (I_3 + \lambda I_4) \geqslant 0. \tag{17}$$

The problem now is the following: First we consider $\lambda > 0$ as given and look for the smallest value of $R_a^{\frac{1}{2}}$ for which (17) holds. We will call this $\bar{R}_\lambda(\mu_1)$. Next we seek the value of λ for which $\bar{R}_\lambda(\mu_1)$ is greatest and we call this $R(\mu_1)$. We see that for a fixed μ_1, if $R_a^{\frac{1}{2}} < R(\mu_1)$ we will have stability. By changing μ_1 $[0 \leqslant \mu_1\ (\infty)]$ one can establish an open region of certain stability near the origin of the $(R_a^{\frac{1}{2}}, R_e)$ cartesian plane. This can be achieved by discussing the maximum problem for a fixed μ_1 and λ in the form

$$-(I_1 + \lambda I_2) = \text{Max.}$$

with the normalizing condition $I_3 + \lambda I_4 = 1$.

By introducing the Lagrangian multipliers $1/R_\lambda$ and $P(r, t)/R_\lambda$ we obtain the Euler-Lagrange equations

$$\vec{v} + \mu_1 R_\lambda \vec{F} . \vec{v} + \frac{R_\lambda}{2} (\hat{k} + \lambda \nabla \psi) \theta = - \nabla P \tag{18}$$

$$\frac{R_\lambda}{2\lambda} (\hat{k} + \lambda \nabla \psi) . \vec{v} = \nabla^2 \theta. \tag{19}$$

Solving these equations we get the required eigenvalue. It may be seen (comparing with Westbrook, 1969) that the variational problem has a solution and that

$$\max. (- I_1 - \lambda I_2) = \frac{1}{R_\lambda}$$

where $\bar{R}_\lambda$ is the greatest lower bound of R_λ^i and R_λ^i are the eigenvalues of (18) and (19).

The motion is stable if $R_a^{\frac{1}{2}} < \bar{R}_\lambda$.

1. Emin Erdogan, M. and Chatwin, R. C., *J. Fluid. Mech.*, 1967, **29** (3), 465.
2. Joseph D. D., *Arch. Rat. Mech. Anal.*, 1966, **22**, 163.
3. Reejhsinghani *et. al.*, *A.I.CH.E.J.*, 1966, **12**, 916.
4. Westbrook, D. R., *Physics of Fluids*, 1969, **12** (8), 1547.

STUDIES ON THE FREE AMINO-ACIDS OF THE HAEMOLYMPH OF *POECILOCERUS PICTUS* (ACRIDAE) DURING OVARIAN CYCLE

SHARADA SHRINGI*, R. C. KANKONKAR AND S. S. RAO
Department of Immunology, Haffkine Institute, Parel, Bombay-12

ABSTRACT

The free amino-acids occurring in the haemolymph of *P. pictus* were studied chromatographically. No major differences were observed in the amino-acid composition of male and of female *P. pictus*. The study of free amino-acids during its ovarian cycle showed that the cystine was low during the moulting period and glutamic and aspartic acids were low at the egg-production stage.

INTRODUCTION

THE occurrence of free amino-acids in relatively high concentration in the haemolymph of insects has attracted the attention of a number of investigators. The haemolymph of a number of species of insects has been studied by Dûchateau *et al.*[1,2], Florkin[3], Florkin *et al.*[4] and Benassi *et al.*[5]. In *Musca*, Pratt[6] found in relative abundance, taurine, an amino-acid that is not known as a constituent of any protein. Besides this, many striking differences have been reported in the relative concentration of individual amino-acids of different species of insects (Dûchateau and Florkin)[7] and even in the same species at different stages of the life-cycle (Florkin)[8].

Recently, Pant and Agarwal[9] studied the haemolymph of the 5th instar larva and adult of *Poecilocerus pictus* and Dikshit *et al.*[10] have investigated the free amino-acids in the haemolymph and testicular tissue of the adult. According to Chen[11], the free amino-acids in the blood of insects make an important contribution to the various regulatory processes. It was, therefore, thought useful to study the free amino-acids in the haemolymph of *P. pictus* during its ovarian cycle.

EXPERIMENTS AND RESULTS

Newly hatched nymphs of *P. pictus* were collected from *Calotropis* plants from fields at Saugar in Central India during their breeding period, *viz.*, July–August. They were reared at room temperature in the laboratory by providing food (calotropis leaves) and water *ad lib.* The insects were bled using the method of Sternburg and Carrigan[12]. The haemolymph obtained from insects of the same age and sex were then pooled to get at least 0·5 ml of the haemolymph for each group. Twelve such groups were formed. They are (1) 5th instar larva, (2) newly hatched male, (3) newly hatched female, (4) 7 days old male, (5) 7 days old female (virgin), (6) 7 days old female (copulated), (7) 15 days old female, (8) 32 days old female (before egg laying), (9) 37 days old female (just after egg laying), (10) 42 days old females (15 days after egg laying), (11) 48 days old female (just laid for the second time) and (12) ovariectomized female.

---

* Senior Research Fellow, Council of Scientific & Industrial Research.

Ovariectomy was performed by removing the ovary from the lateral slits of the anaesthetized insects. The wound was sealed with paraffin wax.

The free amino-acids were studied after removing proteins and fats from the haemolymph using Awapara's[13] method with slight modification. The haemolymph sample (0·1–0·2 ml) was deproteinized with cold ethanol (75% v/v). It was allowed to stand for 15 minutes at 2° C and centrifuged. The supernatant transparent fluid was evaporated to dryness. The resulting residue was defatted by two successive extractions with ether (1 ml) and taken up in distilled water (0·2 ml).

The purified haemolymph was subject to two-dimensional descending paper partition chromatography. The Partridge[14] solvent system as modified by Dikshit *et al.*[10] was adopted which consisted of *n*-butanol-acetic acid- and water (12 : 3 : 5) as the first solvent system, and phenol water [4 : 1 (w/v)] as the second solvent system. The sample was run with the first solvent system for 14 hours. The paper was then air-dried. It was then run at right angles to the direction of the first run with the second solvent system for 12 hours. After drying the paper in air, it was sprayed with 0·4% ninhydrin solution prepared in acetone. The spots were developed by keeping the paper in an oven at 105° C for 8–10 minutes. For the identification of the free amino-acids in the haemolymph, standard amino-acids were spotted at the same time. The size of the amino-acid spot was used as a rough estimate of the increase or decrease of the amino-acids in the different groups.

19 common amino-acids (Isoleucine and leucine taken as one amino-acid) and β-alanine were detected using standard amino-acids for comparison. Besides these, there were some other spots which could not be identified. Cysteic acid and asparagine were absent in all twelve groups of haemolymphs chosen for the present study while all the essential amino-acids, namely—arginine, histidine, isoleucine/leucine, lysine, methionine, phenylalanine, threonine, tyrosine and valine were present in them (Table I).

Cystine was found to be absent in the 5th instar larva and in newly hatched male. It was also absent in the 37 days old female just after egg laying. Besides cystine, glycine wa also found to be absent in the newly hatche males while these amino-acids were found to b present in newly hatched female. Otherwis there was no significant difference between th two groups.

Among the 7 days old virgin and copulate females, concentration of cystine and glycin was found to be more in copulated femal while that of lysine was more in virgin female As compared with the newly hatch females the virgin as well as copulat females contained less amount of methi nine, tryptophan and valine and compar tively more of arginine, histidine, hydrox proline and threonine. The 7 days old male compared with the newly hatched male h more cystine, glycine, histidine and seri Cystine and glycine were totally absent newly hatched males. The comparison of t free amino-acids in the haemolymph of 7 da old male and female showed that argini glutamine, isoleucine/leucine, phenylalanine a proline were present in larger amount and o serine was present in less amount in the fem than in the males.

In the 15 days old female (the period wh the synthesis of yolk and protein takes pl during oocyte development) aspartic a glutamic acids were absent while the concentr tion of cystine, glycine, histidine and hydrox proline had gone down as compared to 7 da old female.

Aspartic and glutamic acids reappeared in t thirty-two days old female in which the yo and protein synthesis was practically comple There was an increase in the concentration tyrosine and decrease in the concentration arginine, glutamine, phenylalanine, proline a threonine in the 32 days old female.

Concentration of many amino-acids was fou to be increased in the 37 days old female. The were arginine, hydroxyproline lysine, methioni phenylalanine, proline, tryptophan and vali while cystine and glutamic acid disappeared.

In 42 days old females (15 days after e laying), the time when the second oocyte tak the position of terminal oocyte (period second egg laying) an excess of α– a β-alanine, cystine, histidine and threonine w noted while the concentration of argini hydroxyproline and lysine decreased. Aspart and glutamic acids and proline were found be absent.

TABLE I

Free amino-acid composition of Poecilocerus pictus

Amino-acids	5th instar larva	Newly hatched male	Newly hatched female	7 days old male	7 days old female		15 days old female	32 days (just before egg laying)	37 days (just after egg laying)	42 days (15 days after egg laying)	48 days (just after second egg laying)	32 days (11 days after ovariectomy)
					V	Cop						
	1	♂ 2	♀ 3	♂ 4	♀ 5	♀ 6	♀ 7	♀ 8	♀ 9	♀ 10	♀ 11	♀ 12
α-Alanine ..	++	+	+	+	+	+	+	+	+	++	+	+
β-Alanine ..	++	+	+	+	+	+	+	+	+	++	+	+
Arginine ..	+	+	+	+	++	++	++	+	++	+	+	+
Aspartic acid ..	++	+	+	+	+	+	–	+	+	–	–	+
Cystine ..	–	–	+	++	+	++	+	+	–	++	+	+
L (+) Glutamine	++	+	++	+	++	++	++	+	+	+	+	+
Glutamic acid ..	+	+	+	+	+	+	–	+	–	–	–	+
Glycine ..	++	–	+	++	+	++	++	+	+	+	+	+
Histidine ..	+	+	+	++	++	++	+	+	+	++	+	+
Hydroxyproline ..	++	++	+	++	++	++	+	+	++	+	+	+
Isoleucine/leucine	+	+	++	+	++	++	++	++	++	++	+	+
Lysine ..	+	+	+	+	++	+	+	+	++	+	+	+
Methionine ..	+	+	++	+	+	+	+	+	++	++	++	+
Phenylalanine ..	+	+	++	+	++	++	++	+	++	++	++	+
Proline ..	++	+	++	+	++	++	++	+	++	–	+	+
Serine ..	++	+	+	++	+	+	+	+	+	+	+	+
Tryptophan ..	+	+	++	+	+	+	+	+	++	++	+	+
Tyrosine ..	++	+	+	+	+	+	+	++	+	+	+	+
Threonine ..	+	++	+	++	++	++	++	+	+	++	+	+
Valine ..	+	+	++	+	+	+	+	+	++	++	+	+
Unidentified spots												
Spots 1 ..	+	++	+	–	–	–	–	–	–	–	–	–
,, 2 ..	–	–	–	–	+	++	–	–	–	++	–	–
,, 3 ..	–	+	–	++	+	++	+	–	–	+	–	–
,, 4 ..	++	–	–	–	–	–	–	–	–	–	–	–
,, 5 ..	–	–	–	–	–	–	–	–	–	–	–	–
,, 6 ..	–	–	–	–	–	–	–	–	–	–	–	–
,, 7 ..	–	–	–	–	–	–	–	+	–	–	–	–

In 48 days old female (just after second egg laying), the pattern of free amino-acids was more or less the same. However, aspartic and glutamic acids were totally absent.

In ovariectomized females concentration of nearly half the free amino-acids decreased and that of proline increased and aspartic acid disappeared once again.

DISCUSSION

The unidentified spots found in the haemolymph chromatogram may include such uncommon amino-acids as α-aminobutyric acid, γ-aminobutyric acid, ornithine and taurine, etc. (Gilmour[15] and Pratt[16]). These amino-acids are known to exist in the free state in the haemolymphs of some of the insects but for the want of these amino-acids in pure form for comparison, our speculation could not be confirmed.

Pant and Agarwal[9], who studied the amino-acid composition of haemolymph in the 5th instar larva of *P. pictus*, reported the absence of arginine and methionine in it. Our finding contradicts their observations. We found these amino-acids present not only in the haemolymph of the 5th instar larva but also in the haemolymph of twelve different groups of *P. pictus* that we have undertaken for the present study.

Cystine was absent in the haemolymph of those larvae which were about to moult but it appeared in the newly hatched females. Lack of cystine in some insects is known to result in interference with moulting process. Such interference in the moulting process has been observed by House[16] and Michelbacher *et al.*[17] in *Blattela* and *Lucidia* respectively when these insects were fed on a diet having reduced cystine content. It therefore appears quite likely that in the case of *P. pictus* also the cystine might have been utilised for the moulting process. It was also absent in just laid females (37 days old).

3,

Though Chen[11] has reported significant differences in the free amino-acid contents of male and female insects, no major differences were observed in the amino-acid composition of male and female *P. pictus* haemolymph. Only cystine and glycine were absent in the male haemolymph.

The disappearance of glutamic and aspartic acids from the haemolymph of 15 days old, 42 days old (15 days after egg laying) and 48 days old females suggests that these two amino-acids which are important in transamination are consumed when there is increased need for protein synthesis. These two amino-acids reappear when the stress on protein synthesis needed for development of egg is less.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. N. K. Dutta, Director, Haffkine Institute, for providing facilities and encouragement. One of us (Miss Shringi) is also grateful to Dr. R. S. Saini, Reader in Zoology and Mr. A. Kar of University of Saugar, for their help and also to the Council of Scientific and Industrial Research for the award of a Senior Research Fellowship.

---

1. Dûchateau, G. H., Florkin, M and Sarlet, H., *Arch. Int Physiol. Biochem.*, 1952 **60** 539.
2. —, — and —, *Biochem. biophys. Acta*, *Amsterdam*, 1952, **8**, **571**.
3. Florkin, M., *Bull. Soc. Zool. Fr.* 1955, **79**, **369**.
4. — and Jeuniaux, C. H., *Physiology of Insects* (Ed. by Rockstein M.), 1964, **3**, 109.
5. Benassi, C. A., Colombo, G. and Allergii, G., *Biochem. J.*, 1961, **80**, 332.
6. Pratt, J. J., *Ann. ent. Soc. Am.*, 1950, **43**, 573.
7. Dûchateau, G. H. and Florkin, M., *Arch int. Physiol. Liege*, 1958, **66**, 573.
8. Florkin, M., "Free amino-acids in insect haemolymph" *IVth Int. Congr. Biochem.*, 1960, **12**, 63.
9. Pant, R. and Agarwal, H. C., *J. Insect Physiol.*, **1964** **10**, 443.
10. Dikshit, T. S. S., Vasuki, K. and Majumdar, S. K., *Ibid.*, 1968, **14**, 367.
11. Chen, P. S., *Ibid.*, 1958, **2**, 128.
12. Sternburg, J. and Corrigan, J. J., *J. Econ. Ent.*, **1959**, **52**, 538.
13. Awapara, A. J., *Arch. Biochem. J.*, 1948, **19**, **172**.
14. Partridge, S. M., *Biochem. J.*, 1948, **42**, 238.
15. Gilmour, D., *The Biochemistry of Insects*, Academic Press, New York & London, 1961.
16. House, H. L., *Can. Entomologist*, 1949, **81**, 133.
17. Michelbacher, A. E., Hoskins, W. M. and Herms, W. B., *J. Expt. Zool.*, 1932, **64**, 109.

ISOTHERMAL GRAIN GROWTH IN STRAINED COMMERCIAL 2 S ALUMINIUM

(MISS) H. CHANDRA AND E. S. DWARAKADASA

Materials Research Group, Department of Metallurgy,
Indian Institute of Science, Bangalore-12

ABSTRACT

In the Recrystallization-Anneal Technique for commercial aluminium a critical strain of 14–15% is necessary for extensive grain growth. The hardness-grain size relation follows nearly a Hall-Petch type relation for moderate and small grain sizes, but deviates at larger grain sizes.

INTRODUCTION

In an attempt to study the effect of grain size on the low temperature plastic flow characteristics of Indian commerical aluminium, it was found necessary to determine the thermal treatments that produce the desired grain size. The recrystallization-anneal technique was employed and the present communication summarizes the results obtained.

MATERIALS AND TREATMENT

Rolled sheets of commercial 2 S aluminium, 2·5 mm in thickness, were used. The average analysis as reported[1] is 99·57 Al, with Fe and Si as the chief impurities. Strips of size 10 mm × 50 mm were cut from the as-received sheet and annealed for 1 hr at 450° C. The initial grain size in all the samples (about 500) was checked and found to be uniform at 0·03 mm.

The annealed specimens were strained plastically by pulling in tension in a universal testing machine at a rate of 1 mm/min. The amount of pull on the machine was calibrated to result in permanent plastic strain in the samples in steps of 1% up to a maximum of about 30%, at which fracture occurred. The strained samples were then annealed in a muffle furnace at a temperature of 400° C for periods upto 24 hrs. No etching was done prior to annealing. At the end of the annealing period the specimens were withdrawn and cooled in still air. Tucker's etchant was used to etch the samples by swabbing until the grains were just revealed. Grain sizes were measured under the microscope at suitable magnifications. Hardness values were recorded on a Vicker's Hardness Tester using 1 kg load.

RESULTS AND DISCUSSION

Figure 1 shows the effect of pre-strain on the grain size in the annealed commercial aluminium for three different annealing periods, *viz.*, 6, 12 and 24 hrs. The data presented in Fig. 1 are obtained from 20 sets of samples, and it is apparent that the results are reproducible. This was further checked by selecting single random values of strains and performing the tests. The critical strain for extensive grain growth is 14–15% as against 2–3% in very pure aluminium[2]. This difference will have to be attributed to the presence of the impurities. By controlling the pre-strain in the range 14–30% it is possible to obtain any desired grain size in the range 0·05 to 15 mm.

The grain size is not very sensitive to the annealing period; it only slightly increases with increasing annealing period, for strains greater than the critical strain, while at lower strains it is unaffected.

In the region of critical strain, no grain boundaries were visible in the gauge length of the specimen. In these cases the grain size developed was taken as that between the first visible grain boundary near the top and bottom grip marks. It is possible that in larger samples, this value is influenced.

Figure 2 shows a plot of hardness (VHN) *vs.* grain size in these samples. A Hall-Petch[3] type relation was tried for fitting the hardness data. It was found that for lower grain sizes, the hardness values were scattered about a straight line of the type:

$$H = H_0 + k\,d^{-\frac{1}{2}} \qquad (1)$$

with $H_0 \simeq 23$ and $k \simeq 1$–2. Thus in commercial aluminium also the Hall-Petch equation may be obeyed, but a more rigorous check would be possible only if the yield point data, especially those obtained at low temperatures, are available.

It may also be noted that in Fig. 2, the hardness of specimens with large grain sizes is surprisingly higher than that predicted by equation (1). One would normally expect the hardness to be lower. This again seems to be a peculiar feature in commercial aluminium. In the present study the different grain sizes were obtained by straining and annealing. Thus, the deviation observed in large grain sizes is probably associated with the dislocation structure as influenced by the critical strain. Such a behaviour as is reported here has not been reported earlier in aluminium. Specimens with very large grains have, therefore, to be viewed from a different angle. In armco iron, brass,

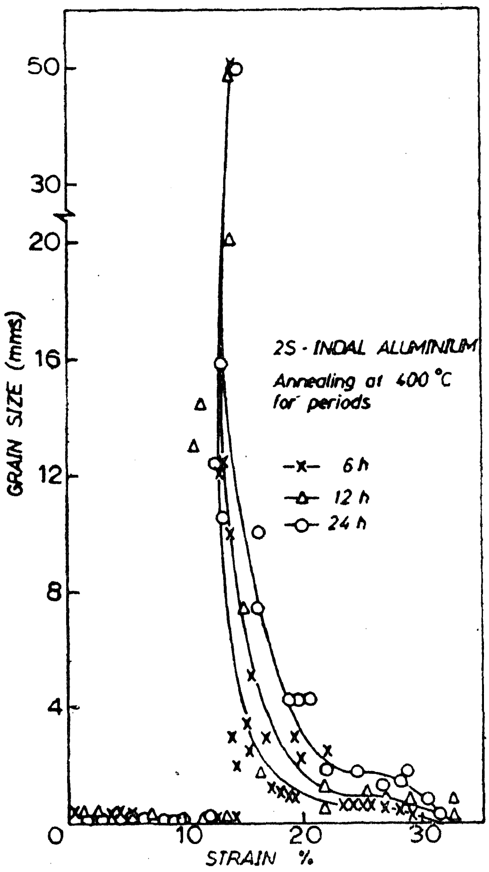


FIG. 1. Variation of post-anneal grain size in commercial 2 S aluminium as a function of pre-strain (%); Annealing temperature: 400° C.

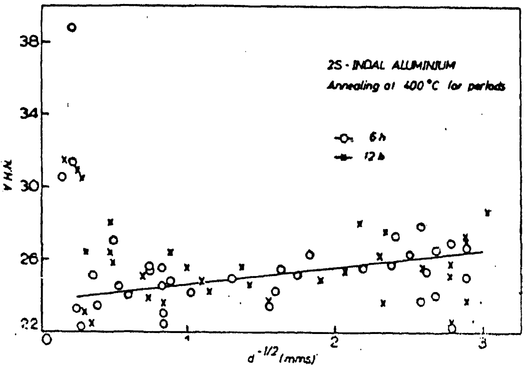


FIG. 2. Variation of hardness (VHN) as a function of grain sizes in strain annealed commercial 2S aluminium

bronze and copper the Hall-Petch relation was observed[3,4] to hold good for values of $d^{-\frac{1}{2}}$ greater than $1\cdot5\ \mathrm{mm}^{-\frac{1}{2}}$. In the present study also it is found that the VHN values are linearly related with $d^{-\frac{1}{2}}$ ($\mathrm{mm}^{-\frac{1}{2}}$), for values greater than 0·5.

In order to give an unequivocal explanation as to the observed anomalous behaviour, it is necessary to make a deeper study of the dislocation structure in coarse-grained commercial aluminium.

CONCLUSION

A critical strain of 14–15% is necessary for extensive grain growth in commercial 2 S aluminium. There exists the possibility of growing single crystals by the recrystallization-anneal technique in this material. Hardness and grain size may be related by a Hall-Petch type equation. The specimens with large grain size show significantly higher hardness.

ACKNOWLEDGMENTS

The authors are thankful to Dr. K. I. Vasu and Dr. Y. V. R. K. Prasad for useful discussions and to other members of the Materials Research Group for their willing co-operation.

---

1. Acharya. B. N.. *M.E. Project Report*, Department of Metaliurgy. I.I.Sc., 1969
2. Eastwood, L. W., James, R. W. and Bell, R. W., *Trans. A I.M.E.*, 1939, **155**, 124.
   See also: Eurof Davies. D., *Practical Experimental Metallurgy* Elsevier Publishing Co. Ltd., 1966, p. 38.
3. Hall, E. O., *Nature*, 1954, **173**, 948.
4. Jindal, P. C. and Armstrong, R. W., *Trans. T.M.S.-A.I.M.E.*, 1967, **239**, 185.

PARTHENIUM WEED IN MYSORE STATE AND ITS CONTROL

JAYACHANDRA

Department of Botany, Bangalore University, Bangalore-1

WHITE top (*Parthenium hysterophorus* Linn.), a member of Compositae, is a native of tropical America[8]. It is reported to be widely held that the seeds of this weed came to India with grains imported from U.S.A. or Canada[2]. In India, the weed was first pointed out in Poona (Maharashtra) by Prof. Paranjape in 1951[10], as stray plants on rubbish heaps and was reported by Rao[8] in 1956, as a new record for the country. Since then it has spread to Kashmir[3], Delhi[6] and Madhya Pradesh[7].

In 1961, Ladwa and Patil[5] recorded this weed as a rare plant from Dharwar (Bombay Karnatak region) and so far the weed does not seem to have been reported from any other part of Mysore State. The author has observed the weed in pure dense stands in Bangalore, Mysore, Arasikere, Birur, Bhadravati, Shimoga and many other stations on Bangalore–Talaguppa railway line. Specimens collected from these regions tally well with descriptions given by Rao[8] and Maheshwari[6]. Considering its spread and abundance the weed may be said to have invaded these regions about six years ago. It inhabits goods shed areas, slopy sides of railway track, roadside, edges of canals, wasteland and new construction sites. Similar habitats have been reported for the weed from other parts of India[7,9,10].

Transport seems to be the sole means of dispersal of the weed over long distances. The weed produces alarmingly large number of small fruits which with the help of the two spongy pads attached to their body can very efficiently be disseminated locally by wind and water.

The seedlings come up in abundance in the early monsoon period. The radical leaves spread radially very close to the ground over a considerable area allowing no other seedling to come up. By their vigorous top growth they can overtake any other species in their neighbourhood. They start flowering when about a month old and remain flowering and fruiting profusely for six to eight months. Thus, the prolificity and aggressiveness of the weed contribute a great deal to its quick spread and successful colonization.

Within about two decades the weed has become naturalised in many parts of our country[7]. The gravity of the situation that would arise if the weed is left unchecked, is indicated by many workers. Vartak[10] reported the weed as spreading like a wildfire in Maharashtra encroaching on cultivated fields and grasslands and that a piece of land yielding 9–10 C.L. of grass hardly yields a single C.L. due to this weed. It has also been a menace in forest nurseries[2]. Shelmire (quoted by Maheshwari[7]) has classed this weed among the top seven for their role in contact dermatitis. Its pollen is known to cause allergy[1]. Parthenin, one of the constituent principles characterised, is known to act as a depressant on nervous system in human beings[2]. If such

FIGS. 1-3. Showing the effect of 'Bromacil' on *Parthenium hysterophorus* Linn. Fig. 1. Control. Fig. 2. Plot treated with Bromacil at 2 kg/ha. Fig. 3. Plot treated with Bromacil at 4 kg/ha.

a noxious weed as this is allowed unchecked, it is sure to lose no time in posing a serious threat to agriculture and public health.

It is reported that, as the weed is not known to be affected by any pest or disease, biological methods for its control do not seem possible[1]. Its impact on human health warns against the recommendation of frequent hand weeding. Hence only chemical methods seem promising for the successful eradication of this weed.

From well-replicated field trials carried out during February–May, 1971, in the fallow land of Department of Botany, Central College, Bangalore, it was found that Bromacil (5-bromo-3-sec. butyl-6-methyluracil) at 2 and 4 kg/ha gave cent per cent control of the weed population at the flowering stage (Figs. 1–3). Within a week, leaves of the treated plants showed progressive browning from tips and margins. Later the inflorescences also dried up. The plants died in about a fortnight and did not show any sign of recovery even after four months. 1 kg/ha was not effective in this regard.

It may be concluded from the trials that Bromacil at the rate of 2 kg/ha is effective in killing white top at the flowering stage.

Diquat (9, 10-dihydro-8 a, 10 a-diazonia-phenanthrene-2 A) and MSMA (monosodium acid methanearsonate), at the rate of 0·5 lb and 4 lb/ac respectively, have been reported to be effective in killing white top under Trinidad conditions[4]. Investigations on the sensitivity of the weed at different stages of its growth to Diquat, MSMA and Bromacil and the feasibility of the application of these chemicals to arable land under Bangalore conditions are in progress. The usefulness of the esters of 2, 4-D, some of which are suggested to be effective[1], is also being tested.

The author is thankful to the Head, Department of Botany, Bangalore University, Bangalore-1, for the facilities and to Dr. K. C. Nag of the DUPONT for the free sample of the weedicide.

---

1. Anonymous. *News letter from Agromore Ltd., Bangalore*, 1970. **1** (5). 1.
2. Chandras, G. S. and Vartak, V. D., *PANS*, 1970, **16**, 212.
3. Hakoo, M. L., *Curr. Sci.*. 1963, **32**, 273.
4. Kasasian, L. and Seeyave, J., *PANS*, 1969, **15**, 381.
5. Ladwa, H. R. and Patil, R. M., *J. Bombay Nat. Hist. Soc.*, 1961, **58**, 68.
6. Maheshwari, J. K., *Curr. Sci.*, 1966, **36**, 181.
7. —, *Ibid.*. 1968, **37**, 326.
8. Rao, R. S., *J. Bombay Nat. Hist. Soc.*, 1956, **54**, 218.
9. Santapau, H., *Indian Fmg.*, 1964, **14**, 23.
10. Vartak, V. D., *Ibid.*, 1968, **18**, 23.

LETTERS TO THE EDITOR

CHEMICAL INVESTIGATION OF THE STEM BARK OF *HESPERETHUSA CRENULATA* (ROXB.) M. ROME

A chemical investigation of the title plant was undertaken because of its reported medicinal properties[1] and the present communication deals with the findings on the examination of the *n*-hexane and benzene extract of the powdered stem bark.

The powdered stem bark (1 kg) was extracted successively with *n*-hexane and benzene. The extract when examined by T.L.C. (silica gel G) indicated the presence of the same components. Hence the extracts were combined after the removal of the solvent and chromatographed on neutral alumina. The column was eluted with petroleum ether, petroleum ether/benzene mixtures (9 : 1, 1 : 1, 3 : 1) and also with varying proportions of benzene-chloroform mixtures and finally with chloroform. The petroleum ether eluate gave two crystalline fractions A and B, and the petroleum ether-benzene eluates gave a mixture of two crystalline compounds. Benzene, benzene-chloroform and chloroform eluates did not give any crystallizable material.

The first crystalline fraction A (125 mg) was rechromatographed thrice on neutral alumina and then recrystallized from petrol/acetone to give a T.L.C. pure compound, m.p. 139–140° C. This gave a single spot on T.L.C., made visible by spraying with 7% ceric sulphate solution in 10% sulphuric acid and then heating to 100° C for few minutes. The pure compound gave an acetyl derivative which after purification by chromatography and recrystallization from petrol/acetone melted at 126–127° C. The original compound was found to be identical with β-sitosterol, which was confirmed by its m.p. and mixed m.p. with an authentic sample of β-sitosterol.

The second crystalline fraction B (450 mg) after repeated chromatography and recrystallization from acetone/methanol gave a T.L.C. pure compound, m.p. 211–212° C. It gave an acetyl derivative with acetic anhydride/pyridine mixture and the pure acetyl derivative had an m.p. 213–214° C. The compound isolated from fraction B was found to be identical with lupeol by its m.p. and mixed m.p. with an authentic sample of lupeol. The identity of the compound as lupeol was also confirmed by a comparison of the I.R. spectrum with that of an authentic sample.

The crystalline mixture of compounds eluted with petroleum ether/benzene mixtures was separated into compounds C and D by chromatography on alumina. The compound C (105 mg) after rechromatography and recrystallization from benzene/petrol gave a T.L.C. pure crystalline substance, m.p. 100–100·5° C (anhydrous) and 68–69° C (hydrated). This was identified as 4-methoxy, 1-methyl 2-quinolone[2] by elemental analysis and spectral data.

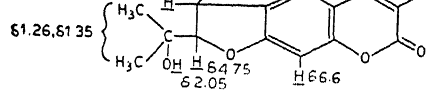
The compound D (90 mg) after recrystallization from acetone/chloroform yielded a sharp melting (189–189·5° C) compound which gave a single spot on T.L.C., which fluoresced blue under ultraviolet light. It showed all the tests of a coumarin. The substance analysed for the molecular formula $C_{14}H_{14}O_4$ (M + peak 246) and showed the following spectral characteristics.

$\nu_{max}^{(nujol)}$ 3400 cm^{-1} (OH) 1720 cm^{-1} (C=O) 1635 cm^{-1} 1575 cm^{-1} (C=C).

$\lambda_{max}^{(EtOH)}$ 226 mμ (shoulder, log ε 4·0) 248 mμ (log ε 3·7) 259 mμ (log ε 3·64) 336 mμ (log ε 4·25). n.m.r.* ($CDCl_3$, TMS internal reference).

δ 1·26 (3 H, singlet) δ 1·35 (3 H singlet) δ 2·05 (1 H, broad singlet, removed by D_2O) δ 3·25 (2 H, doublet J, 8 cps) δ 4·75 (1 H, triplet, J, 8 cps) δ 6·15 (1 H, doublet J, 10 cps) δ 6·6 (1 H, singlet) δ 7·25 (1 H, singlet) δ 7·61 (1 H, doublet J, 10 cps). The compound was optically active and $[\alpha]_D^{20} = +27°$ ($CHCl_3$).

On the basis of these results the compound was identified as marmesin. The n.m.r. spectral assignments are indicated as shown below.



The authors are grateful to Dr. K. Ganapathi, Director, Regional Research Laboratory, Jammu/Kashmir, for providing laboratory facilities. Thanks are also due to Prof. T. R. Govindachari, Director, CIBA Research Centre, Bombay, for providing authentic samples of

β-sitosterol and lupeol and also for the elemental analysis and spectral data.

Regional Research Laboratory (Branch),
Sanat Nagar, Srinagar-5,
Jammu & Kashmir, (India),
May 24, 1971.

M. N. S. Nayar.
M. K. Bhan.
V. George.

---

* 60 m c. spectrum.

1. *The Wealth of India* (Ed. B. N. Sastri, 1959, **5**, 40.
2. *Phytochemistry* (In press).

A FUNGAL FILTRATE WITH PRONOUNCED INHIBITORY ACTION AGAINST SEMLIKI FOREST VIRUS (SFV) IN MICE*

Abstract

Aspergillus flavus Link, strain 6-MFA, produced antiSemliki Forest Virus substance in stationary culture. 87% of the infected treated mice were protected when 100% of the control mice died due to infection. Major activity was confined to acetone precipitated fraction. Under similar conditions of test acetone fraction (helenine) from *Penicillium funiculosum* NRRL 2075 (standard) could induce only 34% protection. The acetone fraction of 6-MFA filtrate was more effective in protecting mice challenged by subcutaneous route than the intracerebral route. Strains of *Aspergillus flavus* varied in antiviral activity.

We have observed striking virus inhibitory action of a mould filtrate, designated 6-MFA, obtained from a laboratory strain of *Aspergillus flavus* Link, grown in Shope's medium[1] and tested in 35 days old Swiss mice infected with Semliki Forest Virus (original strain, Smithburn and Haddow, ATCC).

It was found that with a dose of virus that produced 57% mortality in the control, the crude filtrate (mycelial mat extracted with culture filtrate) was able to protect treated mice to the extent of 80% (Table I). Similar filtrate obtained from *Penicillium funiculosum* NRRL 2075[1] contained much less antiviral activity and under similar conditions *Penicillium chrysogenum*, strain NRRL 1951. B 25[2] and NRRL 1951[2] induced only 70% and 30% protection respectively (Table I).

The acetone precipitated fraction of 6-MFA filtrate prepared according to Shope[1,3-4] exhibited higher antiviral activity. Mice were injected intraperitoneally with freshly prepared acetone fraction 24 hours in advance of subcutaneous challenge by dilution of 10% SFV infected mouse brain homogenate (Table II). Following such a prophylactic injection mice were examined daily, morning and evening, for specific symptoms and death due to paralysis for a period of 14 days. In this manner it was observed that about 87% of mice were protected. The control mice succumbed completely to the same virus dilution within an 8-day period. When activity of the acetone fraction of 6-MFA was compared with activity of similar fraction from *Penicillium funiculosum*, NRRL 2075, it was found that the latter could induce only 34% protection (Table II).

We have further observed that the administration of the acetone fraction 24 hours before SFV given directly into mouse brain does not lead to similar resistance in mice, but the onset time of the disease is slightly prolonged (Table III). The two experiments (Tables II and III) show that the virus inhibitory effect of the acetone extract of 6-MFA filtrate is influenced by the route of virus challenge. Isolation, characterization and mode of action of the antiviral agent and method of its fermentation will be the subject-matter of a separate communication.

A finding of some interest is that even the closely related strains of *Aspergillus flavus* vary markedly in the production of anti-Semliki Forest Virus substance (s).

Powell *et al.*[5] found that a filtrate designated M 5-8450 obtained from fungus *Penicillium stoloniferum* protected 100% of SFV infected and treated mice under conditions when 88% of the untreated mice died due to virus. Shope reported that *Penicillium funiculosum*, NRRL 2075 produced antiviral substance (named helenine) against Col. S. K. and Swine influenza virus[1] during growth in liquid culture that could be extracted with acetone, and observed that the extract protected 77% of the mice challenged with SFV[3], and later[4] achieved nearly 100% protection using a product obtained from culture No. BC. 17-5 by effecting certain improvements in the technique of extraction. Banks *et al.*[2] reported the presence of virus-like particles in penicillin producing strains NRRL 1951 and NRRL 1951 B. 25 of *Penicillium chrysogenum*, and found that both the virus particles and the *ds*-RNA derived from these viruses were active inducers of interferon in animals[6]. Our work incidentally confirms the unpublished results of Banks *et al.*[6] that virus containing and penicillin producing mould *Penicillium chrysogenum*, strains NRRL 1951 and NRRL 1951 B. 25, both induce production of antiviral substances. We have shown that the antiviral activity of growth

TABLE I

Mice treated with filtrates of fungi given i/p and challenged s/c by SFV

Treatments (crude filtrate)	Medication	Challenge virus	Proportion of mice survived	Survival (%)
Aspergillus flavus, strain 6-MFA	0,5 ml ×5 2 doses given 12 hourly one day ahead and 3 after virus 24 hourly	0·5 ml of 10^{-2}	12/15	80
Penicillium funiculosum, NRRL 2075	,,	,,	8/14	57
Penicillium chrysogenum, NRRL 1951. B 25	,,	,,	14/20	70
Penicillium chrysogenum, NRRL 1951	,,	,,	6/20	30
Control	No treatment	,,	6/14	43

TABLE II

Mice treated i/p with acetone fraction of A. flavus *compared with standard* P. funiculosum, *NRRL 2075 challenged with SFV given s/c*

Fungi	Medication	Challenge virus	Surviving mice	Survival (%)
A. flavus 6-MFA	2·00 ml×1 i/p, 24 hrs before virus	0·5 ml of 10^{-1}	14/16	87
P. funiculosum NRRL 2075	,,	,,	6/18	34
Control (buffer saline)	,,	,,	0 18	0

TABLE III

Mice treated i/p with acetone fraction of A. flavus *compared with standard* P. funiculosum, *NRRL 2075 challenged with SFV given i/c*

Fungi	Medication	Challenge virus	Mice surviving	Survival (%)
A. flavus, 6-MFA	2·00 ml×1 i/p	0·03 ml of 10^{-1}	0/10*	0
P. funiculosum NRRL 2075	,,	,,	0/10	0
Control (buffer saline)	,,	,,	0/10	0

* Symptom onset time prolonged in the case of mice treated with acetone fraction of *A. flavus*.

products of these two moulds extends to SFV infection in Swiss mice which are protected prophylactically to a fairly large degree.

We thank Dr. M. L. Dhar and Dr. A. B. Kar, Director and Deputy Director of the Central Drug Research Institute, for their interest in this project, and Dr. K. G. Mukherjee and Dr. B. M. Johri of Delhi University, for the supply of original cultures of fungi from their collection.

Central Drug Research Institute,
Chattar Manzil Palace,
Lucknow, *July* 8, 1971.

K. CHANDRA.*
B. M. GUPTA.
R. K. MAHESHWARI.**

---

* Communication No. 1659

** Junior Research Fellow, C.S.I.R., India.

1. Shope, R. E., *J. Exp. Med.*, 1953, **97**, 609.
2. Banks, G. T., Buck, K. W., Chain, E. B., Darbyshire, J. E. and Himmelweit, F., *Nature*, 1969, **222**, 89.
3. Shope, R. E., *J. Exp. Med.*, 1953, **97**, 627.
4. —, *Ibid.*, 1966, **123**, 213.
5. Powell, H. M., Culbertson, C. G., McGuire, J. M., Hoehn, M. M. and Baker, L. A., *Antibiot. Chemother.*, 1952, **2**, 432.
6. Banks, G. T., Buck, K. W., Chain, E. B., Darbyshire, Joan, E., Himmelweit, F., Ratti, G., Sharpe, T. J. and Planterose, D. N., *Nature*, 1970, **227**, 505.

PALAEOMAGNETISM AND THE CONTINENTAL DRIFT

RESULTS of palaeomagnetic studies on Indian rocks by Deutsch. *et al.* (1959), Athavale *et al.* (1963), Prasad (1966), etc., have given significant support to the hypothesis of Continental drift.

During the course of investigation of the pre-Cambrian dolerites of the Tirupati area, oriented samples were collected from 25 dykes for palaeomagnetic work. The natural remanent magnetic directions and the intensities of the dykes were measured with suitably sensitive astatic magnetometers. Stability

TABLE I

	Site location		Number of samples	Mean direction		Cone ot confidence	Ancient latitude of the site
	Latitude	Longitude		Azimuth	Dip		
Group I dykes ..	14° N.	79° E.	16	349°	−17°	3°	9° S.
Group II dykes ..	14° N.	79° E.	42	171°	9°	1°	5° S.
Group III dykes ..	14° N.	79° E.	18	278°	−22°	4°	11° S.

tests were carried out by making use of the A.C. cleaning apparatus and Thermal Demagnetisation apparatus constructed by Radhakrishnamurthy and Sahasrabudhe (1965) in the Tata Institute of Fundamental Research, Bombay. The results of preliminary measurements and the cleaning operations revealed that some of the dykes are consistent and others are inconsistent. The plots of the consistent dykes fall into three distinct groups (Fig. 1) indicating that these three groups of dykes acquired magnetization in three different periods. Group I dykes are normally magnetized whereas Group II dykes are reversely magnetized. Group III dykes show an intermediate direction, the azimuth being around 280° east of north with negative dips around 20°.

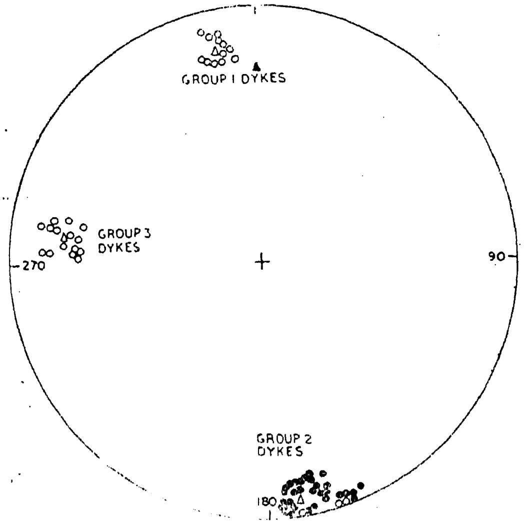


FIG. 1. A C. cleaned directions for the consistent dykes of the Tirupati area. (O, upward dips; ●, downward dips; △, mean of the cleaned directions; ▲ present dipole.)

The ancient latitudes for the Tirupati area have been calculated using the mean magnetic directions and are given in Table I. The formulae given by Blackett, *et al.* (1960) have been used in these calculations. The radius of circle of 95% confidence has been calculated using the formulae given by Fisher (1953). From Table I it is evident that the Tirupati area occupied a position in the southern hemisphere near the equator during the pre-Cambrian period.

The author thanks Dr. C. Radhakrishnamurthy of the Tata Institute of Fundamental Research, Bombay, Dr. K. V. Suryanarayana and Dr. C. V. R. K Prasad of S.V. University, Tirupati, for their helpful suggestion. Professor D. Lal of T.I.F.R. kindly provided facilities in the Rock Magnetism Laboratories.

Dept. of Civil Engg.,
S.V. University,
Tirupati, *July* 7, 1971.
K. ANJANAPPA.

---

1. Athavale, R. N., Radhakrishnamurthy, C. and Sahasrabudhe, P. W., *Geophy. Jour. Roy. Astro. Soc.*, **1963**, **7**, **304**.
2. Blackett, P. M. S., Clegg, J. A. and Stubbs, P. H. S., *Proc. Roy. Soc*, **1960**, **256 A**, 291.
3. Deutsch, E. R., Radhakrishnamurthy, C. and Sahasrabudhe, P. W., *An. De. Geophysique*, 1959, **1**, **39**.
4. Fisher, R. A., *Proc. Roy. Soc.*, **1953**, **217 A**, 295.
5. Prasad, C. V. R. K., *Unpublished Ph.D. Thesis*, S.V. University, **1966**.
6. Radhakrishnamurthy, C. and Sahasrabudhe, P. W., *Jour. Ind. G.U.*, **1965**, **2**, **5**.

ON THE TEMPERATURE AND SALINITY STRUCTURE OF THE SEA OFF WALTAIR AT THE COMMENCEMENT OF 'SINKING' SEASON

BASED on the results obtained during the oceanographic cruise programme conducted by the Andhra University during 1952–57, several papers have been published on the hydrography of the Bay of Bengal[1-3]. The literature so far published points out that the physico-chemical conditions prevailing in the 0–24 km zone off the east coast are highly variable and are influenced by the river drainage, the north-east and south-west monsoons, the resulting surface currents and the associated sinking and upwelling phenomena.

The observations made during September 1957 on the temperature and salinity structure are of special significance as they depict the temperature and salinity conditions prevailing at the commencement of the sinking season off Waltair.

During the commencement of the sinking season (Fig. 1) the temperature of the surface waters is high and gradually decreases with depth. The sinking water seemed to displace the cold subsurface water farther offshore. The orientation of the isotherms indicates that the surface-bottom differences in the near-shore waters (between Stns. 723–724) are comparatively less pronounced than those away from the shore (between Stns. 725–726).

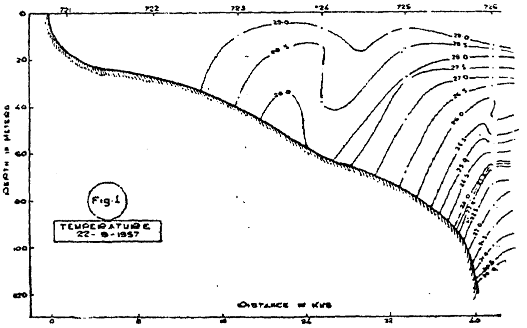


FIG. 1

The occurrence of the lowest salinity at Stn. 724 (Fig. 2), which is located at about 24 km away from the coast, suggests that this particular station is near the axis of the south-westerly current bringing in large quantities of freshwater from north of the coast. Strong vertical gradients are noticed between 0 and 25 m depth. The magnitudes of these gradients gradually increase with distance from the coast up to Stn. 724, beyond which the magnitudes gradually decrease. The downward bending of the isohalines 29 to 32%, presumably under the pressure of the water banking in the near-shore region, is clearly indicative of the sinking process. This downward bending is not noticeable in the superficial layers.

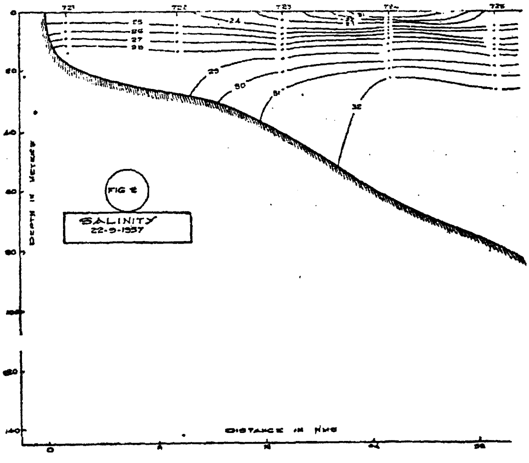


FIG. 2

I am indebted to Prof. P. N. Ganapati and Dr. Eugene C. La Fond for their helpful suggestions. I express my thanks to Prof. K. Hanumantha Rao for his encouragement. I thank the authorities of the Andhra University for providing all the facilities to carry out this work.

Andhra University, P. V. BHAVANARAYANA.
Waltair, *July* 5, 1971.

---

1. Banse, K., *Kieler-Meeresforschungen*, 1960, **16**, **214**.
2. Ganapati, P. N and Satyanarayana Rao, T. S., *J. Mar. biol. Ass., India*, 1959, **1**, 224.
3. La Fond, E. C., *Proc. Ind. Acad. Sci.*, **1957**, **46**, **1**.

NATURE OF THE GREEN PIGMENT FROM THE SUB-EPIDERMAL CONNECTIVE TISSUE OF *SIPUNCULUS NUDUS* L., A SIPUNCULAN WORM

ANDREAE[1] observed the presence of multinuclear cells of irregular outline, filled with granules of green or greenish-yellow pigment, in the meshes of the sub-epidermal connective tissue in *Sipunculus nudus*. Subsequently, Ward[2] reported that the occurrence of these pigmented cells was so characteristic of the group. The author also suggested that the greenish pigment may be an excretory product and therefore deserves special consideration for an understanding of the metabolic pattern of the sipunculan worms. But no attempt has so far been made to study the nature of the pigment in question in Sipuncula, hence the present study.

Sipunculan worms of the species *Sipunculus nudus* L., commonly available along the Madras coast, were the materials used. The sub-epidermal connective tissue together with the pigmented cells, separated from freshly dissected specimens, was homogenized in a mortar with ice-distilled water. The pigment from the homogenate was extracted with acetone containing 10% (W/V) hydrochloric acid. The acetone in the extract was then evaporated in a stream of air and the acid removed by evaporation *in vacuo* in a desiccator over calcium chloride and potassium hydroxide at room temperature (28–30° C). The dried residue was a greenish amorphous powder, and the same was used for all further analyses.

The chemical nature of the pigment was studied following the methods outlined by Sundara Rajulu[3,4]. For thin-layer chromatography, silica gel-G plates were used. Isopropanol-ammonia-water (20 : 1 : 2 V/V) was used as irrigating solvent. The absorption spectrum of the pigment was examined in a Beckman DU ultraviolet spectrophotometer.

The pigment dissolved in water and the aqueous solution exhibited weak yellow-green fluorescence in ultraviolet light. The pigment was also soluble in methanol and ethanol but insoluble in diethylether, petroleum ether and chloroform. It was precipitated from solution in glacial acetic acid by the addition of diethylether.

Reduction of the pigment with dithionite or borohydride in aqueous solution caused its colour to change from green to yellow-brown. The pigment gave a typical Gmelin reaction with concentrated nitric acid turning in succession to violet, orange-red and finally yellow. The reaction was arrested at the violet stage when a mixture of concentrated nitric acid and sulphuric acid (1 : 1 V/V) was used as the oxidising agent.

The pigment was chromatographically homogeneous. In thin-layer chromatography it had a Rf. value of 0·63. The absorption spectrum of the pigment in methanol containing 5% (W/V) hydrochloric acid shows maxima at 370 and 680 mμ and inflexions at 270, 330 and 440 mμ (Fig. 1).

The greenish-yellow colour of the pigment, the reactions and its Rf value in thin-layer chromatography identify the pigment as belonging to the class bilatrienes.[5] The absorption maxima at 370 and 680 mμ exhibited by the solution of the pigment in methanolic-hydrochloric acid are again characteristic of bilatrienes. The presence of inflexions in the absorption spectrum at 440 and 330 mμ may suggest that the pigment in question may not be a biliverdin or mesobiliverdin, but bilirubin[6].

Bilatrienes are said to be responsible for the green or greenish-yellow colour of the integument and shells of some bivalve molluscs where the pigment is formed as an end-product of myoglobin metabolism[5,7]. But there is no report of the occurrence of myoglobin in sipunculan worms. Therefore the metabolic source of the bilatriene in the pigmented cells in the sub-epidermal connective tissue in sipunculan worms deserves further study.

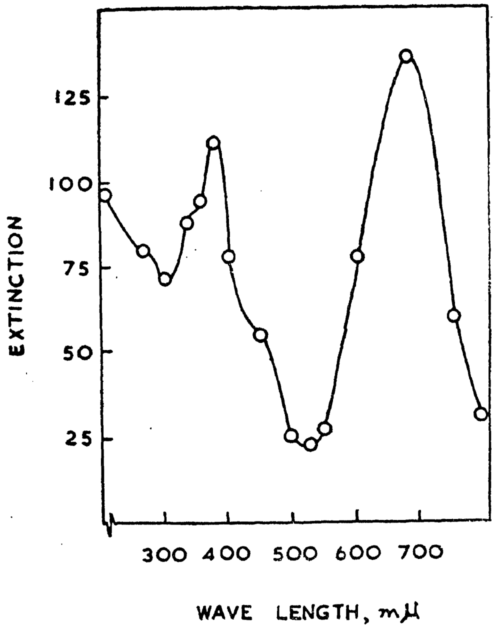


FIG. 1. Absorption spectrum of the green pigment from *Sipunculus nudus*. (Extinction coefficient calculated from absorbance value.)

I wish to thank Dr. G. Sundara Rajulu for his valuable guidance and encouragement during the course of this work. I am indebted to Prof. G. Krishnan for helpful discussions and provision of facilities. The financial support from the University Grants Commission is gratefully acknowledged.

Dept. of Zoology, R. MANAVALARAMANUJAM.
University of Madras,
Madras-5; *June* 30, 1971.

---

1. Andreae., J.. *Zeitschr. f. wiss. Zool.*, 1881, **36**, 201
2. Ward. H. B., *Bull. Mus. Comp. Zool. Harvard*, **1891**, **21**, **143**.
3. Sundara Rajulu, G., *Sci. & Cult.*, 1968. **34**, 297.
4. —, *Indian J. Exp. Biol*, 1970. **8**, 223.
5. Bannister, W. H., Bannister, J. V. and Micallef, H., *Comp. Biochem. physiol.*, 1968, **24**. 839.
6. Grav, C. H., Kulczvcha, A. and Nicaelson, D. C., *J. Chem. Soc.*, 1961, **1961**, **2268**.
7. Tixier, R., *Mem. Mus. Natn. Hist. nat. Paris*, 1952, **5**, **41**.

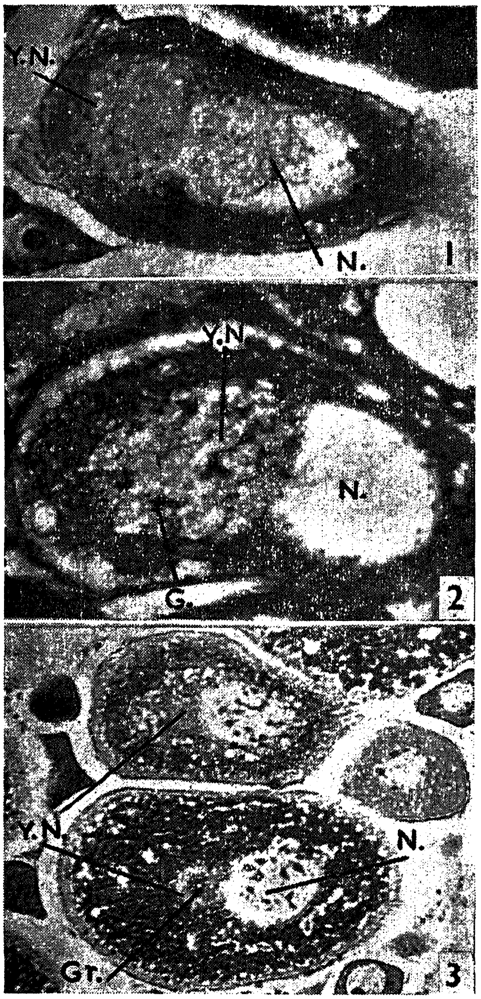
THE YOLK NUCLEUS OF BALBIANI IN INDIAN FRESHWATER GOBY, *GLOSSOGOBIUS GIURIS* (HAM)

WITTICH (1845)[1] described the yolk nucleus of Balbiani in the oocytes of spiders and Hubbord (1894)[2] described it in the oocytes of the fish, *Cymatogaster aggregatus*. Wallace (1904)[3] made a comparative study of the yolk nucleus in a number of marine teleosts, concluding that the yolk nucleus is in the form of a spheroid body, which travels to the periphery of the oocyte where it gets spongy, breaks into pieces and ultimately degenerated giving rise to the fats, confounded and connected with another structure, the centrosphere. Franz (1909)[4] observed only one structure in the oocytes of *Pleuronectes platessa* corresponding to the centrosphere of Wallace. Hubbord (1898), Wheeler (1924)[5], Subramaniam and Aiyar (1935)[6] and Sathyanesan (1959)[7] regard the yolk nucleus as an organelle of nuclear origin which passes, through the nuclear membrane to invade the cytoplasm. However, its cytoplasmic origin has been held by Narain (1951)[8], Chaudhry (1952)[9] and Nayyar (1964)[10] and they find a relationship between yolk nucleus, golgi, and mitochondrial elements. Bara (1960)[11] also observed an association between the yolk nucleus and mitochondria.

An attempt has been made here to study the structure and functional significance of the yolk nucleus in *Glossogobius giuris* (Ham.).

In the late peri-nucleolus stage of the oocytes, the yolk nucleus makes its first appearance *de novo* in the cytoplasm as a homogeneous body and later on it assumes a vesicle-like structure with distinct granules within it. At the yolk-vesicle stage, the yolk nucleus enlarges and attains a size which is equal or sometimes even bigger than the nucleus itself (Figs. 1 and 2). The granules take up dark colour with haematoxylin against light background. With further growth of oocytes, the carminophilic and eosinophilic granules, having a similar tinctorial behaviour to the yolk granules, appear in the centre of the yolk nucleus (Fig. 3). The yolk nucleus lasts through the primary, secondary and tertiary yolk stages. As the oocyte attains maturity, the yolk nucleus becomes spongy and shows signs of degeneration. It is completely disorganised in the prematuration stage and is not seen in the mature oocytes. With the staining techniques used (Ehrlich's Acid Haematoxylin and Eosin, Delafield's Haematoxylin and Eosin and Heidenhain's Azan) in the present study, the type of zonation reported by Chaudhry (1952) in *Triacanthus brevirostris* and Gopal Dutt (1964)[12] in *Anabas scandens* could not be seen.

According to Wheeler (1924), 'the yolk nucleus is inactive; at least it does not contribute visibly to the formation of yolk'. Chaudhry (1952) assigned some indirect role to the yolk nucleus in the formation of yolk possibly acting as a catalytic agent. He, however, infers its initial focus on the growth and dispersal of various significant cytoplasmic inclusions and also taking a leading part in the change-over of these inclusions into reserve food material. Nayyar (1964) has remarked that the yolk nucleus initiates the synthesis of lipids.



FIGS. 1–3. Photomicrographs of T.S. of ovary of *G. giuris* showing: **Fig. 1.** The yolk nucleus in late-peri-nucleolus stage of the oocyte, ×450. **Fig. 2.** Fully formed yolk nucleus in yolk-vesicle stage of the oocyte, × 450. **Fig. 3.** The yolk nucleus in yolk-stages of the oocyte, × 200. G., Granules in the vesicle of yolk nucleus; Gr., Granules in the yolk nucleus with similar tinctorial behaviour to the yolk granules; N., Nucleus of the oocyte; Y.N., Yolk nucleus.)

In the present study on *G. giuris* there seems no visible role of the yolk nucleus in the process of vitellogenesis as in many teleosts (Wallace, 1904; Chaudhry, 1952; Nayyar, 1964). All the same the appearance of yolk nucleus in the late peri-nucleolus stage, its presence throughout the yolk stages and disappearance in the mature ovum after the process of vitellogenesis is completed, points out its possible indirect role in the vitellogenesis of the oocyte, thus confirming the observations of Chaudhry (1952).

Dept. of Zoology, H. N. BHARGAVA.
University of Saugar, D. N. SAKSENA.
Saugar, India, *June* 23, 1971.

---

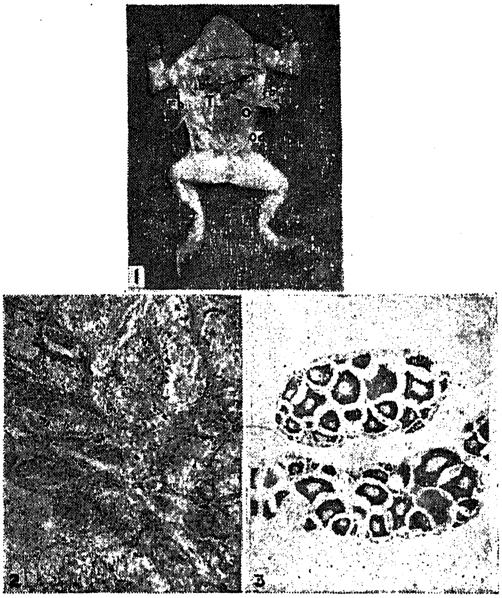
*1. Wittich, Von G. H., *Inaugural Dissertation Halis saxounm*., 1845.
*2. Hubbord, J. W., *Proc. Amer. Phil. Soc.*, 1894, **33**.
3. Wallace, W., *Quart. J. Micro. Sci.*, 1904, **47**.
4. Franz, V., *Wiss. Meeresunters*, 1909, **9**.
5. Wheeler, J. F. G., *Quart. J. Micro. Sci.*, 1924, **68**.
6. Subramaniam, M. K. and Aiyar, R. G., *J. Roy. Micro. Soc.*, 1935, **55**.
7. Sathyanesan, A. G., *Naturewissenschaften*, 1959, **46**.
8. Nayyar, R, P., *Quart. J. Micro. Sci.*, 1964, **105**.
9. Narain, D., *Proc. Nat. Acad. Sci. India*, 1951, **21**.
10. Chaudhry, H. S., *Z. Zellforschg*, 1952, **37**.
11. Bara, G., *Rev. Fac. Sci. Uni. 1st Serie B*, 1960, **25**.
12. Gopal Dutt, N. H., *Quart. J. Micro. Sci.*, 1964, **105**.

* Not consulted in original.

SEXUAL GYNANDROMORPHISM IN THE TOAD, *BUFO MELANOSTICTUS* (SCHN.)

WHILE being engaged with the reproductive biology of the toads, we have come across a very unique and a classic case of lateral gynandromorphism in the male toad, *Bufo melanostictus* (Schn.). Occurrence of hermaphroditism with Bidder's organ both in male and female toads is very common and, of ovotestis or testis with pseudovocytes has also been reported very rarely[1-4]. In all these cases there is a dominant and a rudimentary gonad showing bilateral disposition in their appearance and differentiation. The accessory reproductive organs follow the dominant gonad. The appearance of ovotestis or testis with pseudovocytes may be on one side only or on both sides. But at least the dominant gonad shows bilateral differentiation. In human beings many hermaphroditic varieties have been reported, like *lateral hermaphrodites having ovary on one side and a testis on the other*, bilateral hermaphrodites, having both ovarian and testicular tissue on both sides, unilateral hermaphrodites having an ovary or testis on one side and an ovotestis on the other[5]. But the term lateral hermaphroditism is not reported in Anurans. So far no one has reported a case of an Anuran having an overy and oviduct on one side and a testis on the other. The case, now under report, had testis on the right side attached to the anterior end of the right kidney with well-developed fat bodies. On the left side there was a strip of rudimentary or immature ovary with a well-developed oviduct (Fig. 1). The differentiation of right side gonad into a testis and the left side gonad into a ovary and consequent differentiation of müllerian duct of that side into an oviduct may be due to different sensitivity to the hormone, during differentiation of gonads.

The testis, ovary and kidney were fixed in 10% formalin, sectioned at 8 μ, stained in Heidenhain's haematoxylin and haematoxylin-eosine respectively. Histological observations of the testis show that it is well differentiated with seminiferous tubules, cell nests, sperm bundles, free sperms and interstitial cells (Fig. 2). The observations of ovarian section show that the ovary is juvenile with only immature oocytes (Fig. 3).



FIGS. 1-3. Fig. 1. Photograph of the sexual gynandromorph Toad showing testis on the left side and ovary and oviduct on the right side of the photograph. × 0·50. Fig. 2. Transverse section of the testis, × 180. Fig. 3. Transverse section of the ovary, × 180. (Fb = Fat bodies; Ov=Ovary; Od=Oviduct: T=Testis.)

On going through the literature we find no mention of any such case as this in the Amphibia and the present report seems to be unique to Anurans. Such phenomenon was also found in case of birds, where a chicken was found on autopsy with a testis and vas deferens on the right and an ovary with oviduct on the left side[6,7]. This unilateral differentiation of gonads and accessory ducts seems to be similar to what is described as gynandromorphism in *Drosophila* species[8].

We are indebted to Prof. M. R. Rajasekarasetty for his advice and encouragement and to the University of Mysore for awarding a Research Fellowship to one of us (B. S. T.). We are thankful to Mr. Ramakrishnaraju for helping us in the preparation of photomicrographs.

Dept. of Zoology, B. S. THYAGARAJA.
Manasa Gangotri, H. B. DEVARAJ SARKAR.
University of Mysore,
Mysore-6, India, *July* 12, 1971.

---

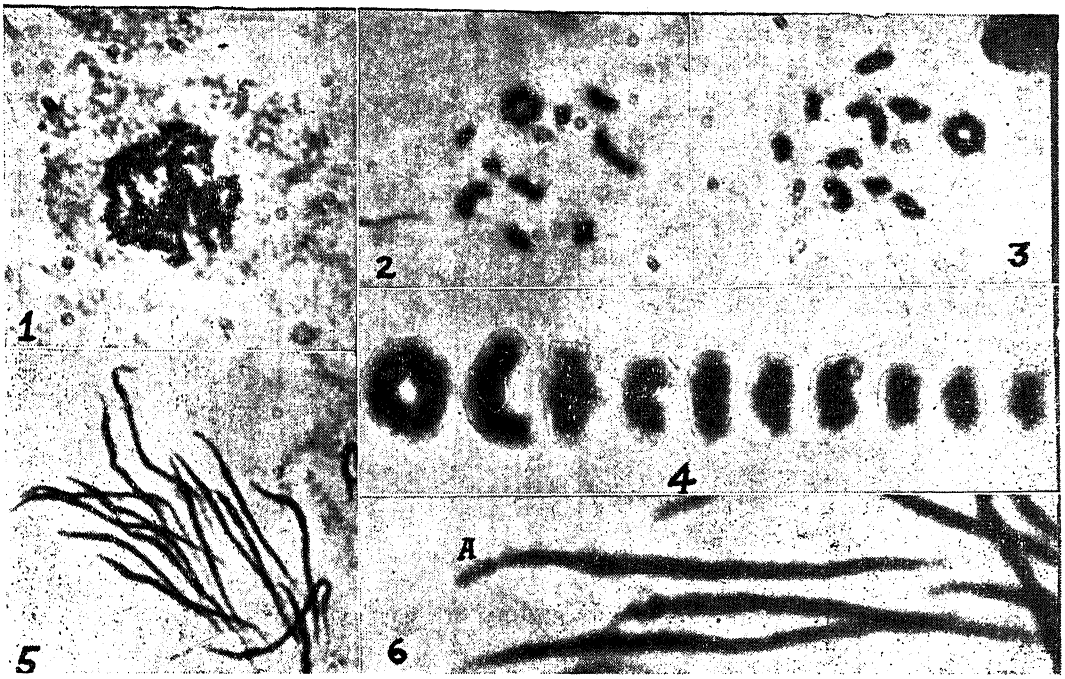
1. Dodd, J. M., "General gonadotrophic hormones in lower vertebrates," In Marshall's *Physiology of Reproduction*. 3rd Ed. (Ed. A. S. Parkes), Longman-London. 1965, 1, 2. 480.
2. Turner, C. D. *General Endocrinoolgy*, 2nd Edn., Saunders Co., Philadelphia, 1960, p. 222.
3. —, *Ibid*., 4th Edn., Saunders Co., Philadelphia, 1966, p 375.
4. Jollie, M., *Chordate Morphology*. Reinhold Eastwest Press, 1968.
5. Ursula Mittwoch. *Sexchromosomes*, Academic Press. Inc, N.Y., 1967.
6. Crew, F. A. E., 'The factors which determine sex," In Marshall's *Physiology of Reproduction*, 3rd Edn. (Ed. A. S. Parkes). 1964, p 2.
7. Van Tienhoven, A. "Endocrinology of reproduction in birds." In *Sex and Internal Secretion* (Ed. W. C. Young). 1961, p. 2.
8. Strickberger. M W., *Genetics*, Macmillan Co., N.Y., 1968, p. 467.

SOME CYTOLOGICAL OBSERVATIONS IN THE DIGENETIC TREMATODE *PHILOPHTHALMUS* SP. FROM EAGLE

THE controversy about the chromosome numbers in the various digenetic trematodes has been there from the time of Goldschmidt[1-3]. With ambiguous mention of them[4], the families worked out are Dicrocoelidae[3], Plagiorchiidae[4-6], Schistosomatidae[7], Fasciolidae[8,9] and Hemiuridae[10], among which the second one has been extensively investigated in view of its wide distribution. The family, Philophthalmidae, having a distribution exclusively in the orbits and occasionally in the intestines and cloaca of birds is rare in mammals with two species reported from the human eye[11]. There is a lacuna in our knowledge on the cytology of the only two genera, *Philophthalmus* and *Pygorchis* Looss 1899, belonging to this family[2]. The observations reported here are from seven specimens of the rather rarely available *Philophthalmus* sp. collected from the ocular region of the eagle at Jagtial in Karimnagar District of Andhra Pradesh.

The assumption that Platyhelminth cytology is difficult, is evident from the nonapplicability of the known procedures and the adaptation of lengthy, fastidious and cumbersome mammalian schedules to cestodes[12] or trematodes[3]. We have devised a simple technique that has proved successful. The parasites isolated from the ocular region of the bird were washed in Ringer's B solution to give a vertebrate environment. In order to get a good spreading of the chromosomes, the parasites were pretreated for 2 hours at room temperature in 10 ml. Ringer's B solution with 2 ml. of 0·025% colchicine. The parasites immobilised on a microscopic slide by a dropwise addition of ethyl alcohol and acetic acid (3 : 1) fixative were flattened well between two slides. After fixation for 6 hours, one of the preserved specimens was stained by the borax carmine technique for identification, while the others released with a brush were dissected out for their testes located one above the other in the posterior end. The testes were either employed directly from the fixative or after storage in 70% alcohol following preservation. After a wash in distilled water for 5 min., hydrolysis in 1 N HCl at 60° C for 8 min., mordanting in 4% ferric ammonium sulphate for 30 min., wash in water for 10 min., with two changes of 5 min., each, the testes were stained in Heidenhain's haematoxylin for 60 min., squashed and made permanent as described elsewhere[13].

Figure 1 is of a cell in pachytene stage. The screening of a good number of metaphases has led to an unambiguous count of ten bivalents at metaphase I as in Figs. 2 to 4. One of them presents the appearance of a large sized ring and it seems to be the largest bivalent as in the case of *Haematoloechus medioplexus* Stafford (Plagiorchiidae)[4]. An analysis of the mitotic stages was precluded in view of the rarity of the specimens and the nonavailability of the intermediate invertebrate host. The meiotic stages reported here from adult parasites would, however, indicate the diploid chromosome number of *Philophthalmus* sp. to be 20. The sperm morphology which is interesting (Fig. 5) shows a gradual tapering towards both the ends with the acrosome (A) having a convex or double convex shape separated by a waist (Figs. 5 and 6). After an initial widening behind this part the head region tapers down towards the tail (Fig. 6).



FIGS. 1–6. Haematoxylin squashes of the testes of *Philophthalmus* sp. Fig. 1. Pachytene, × *ca.* 1 950, Figs. 2–3. Metaphase I with ten bivalents. Note the ring-shaped bivalent in each micrograph, × *ca.* 1 950. Fig. 4. Karyotype of the enlarged metaphase I bivalents seen in Fig. 3 to show their clarity, × *ca.* 4 200. Fig. 5. A group of sperms with biconvex or convex acrosomes, × *ca.* 1,950 Fig. 6. An enlargement of one of the several sperms from Fig. 5 demonstrating the shape of the acrosome (A), × *ca.* 5,400.

Thus the simple technique, described here, has led to determin the $2n$ number of chromosomes in *Philophthalmus* sp., as 20, without any ambiguity. The acrosome possesses a convex or biconvex appearance.

We are thankful to Prof. O. S. Reddi, Department of Genetics, for his interest and to Dr. G. P. Jaiswal, Department of Zoology, Osmania University, for identifying the specimen. One of us (P. V. R.) is grateful to Sri. V. Kondal Rao, Principal, Government Arts and Science College, Jagtial, for his encouragement.

Dept. of Zoology, P. VENKAT REDDY.
Govt. Arts and Science
College, Jagtial, A.P.
and
Dept. of Genetics, S. SUBRAMANYAM.
Osmania University,
Hyderabad-7, A.P., *July* 16, 1971.

---

1. Goldschmidt, R., *Zool. Jb. Anat.*, 1905, **21**, 604 (cited by Ben Dawes).
2. Dawes, B., *The Trematoda*, Cambridge University Press, 1946, p. 495.
3. Larrouy, G., Ruffie J. and Malaspina, L., *Comp. Rend. Acad. Sci* (*Paris*), 1965, **260**, 3156.
4. Burton, P. R., *Jour. Morph.*, 1960, **107**, 93.
5. Pennypacker, M. I., *Arch. Biol.*, 1936, **47**, 309 (cited by Burton).
6. —, *Jour. Morph.*, 1940, **66**, 481 (cited by Burton).
7. Ikeda, K. and Makino, S., *Jour. Hokkaido Univ.*, Japan, 1936, p. 57.
8. Sanderson, A. R., *Nature*, 1953, **172**, 110.
*9. Lochin Tsong, *Bull. Inst. Zool. Acad. Sinica.*, 1969, **8**, 1.
*10. Jones, A. W., *J. Tennessee Acad. Sci.*, 1956, **31**, 186.
11. Penner, L. R. and Fried, B., *Jour. Parasitology*, 1963, **49**, 974.
12. Proffitt, M. R and Jones, A. W., *Stain Technol.*, 1966, **41**, 159.
13. Subramanyam, S. and Prem Veer Reddy, G., First All India Congress of Cytology and Genetics, University of Punjab, Chandigarh, 30th September 4th October 1971.

* Not consulted in original.

OCCURRENCE OF THE GENUS *HERPOBASIDIUM* LIND IN INDIA

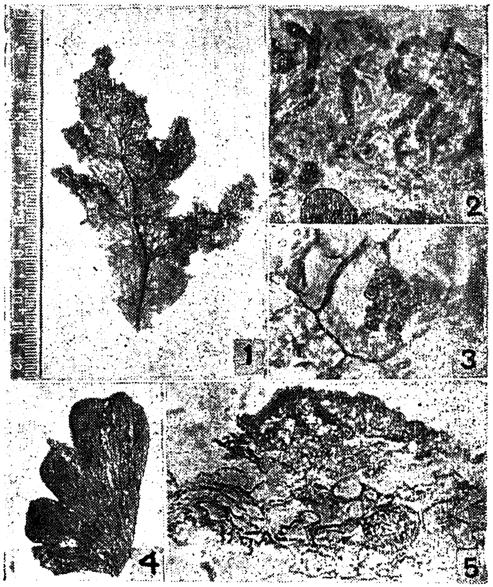
DURING the course of field work on the Pteridophytic flora of the Western Ghats of Maharashtra State the author collected a few fern species parasitised by different fungi. One such, a fungus *Cercospora angiopteridis* Boedijn causing the leaf spots on *Angiopteris evecta* Hoffmann was reported recently by the author^5 from India. Another interesting fungus infecting the fronds of *Aspidium cicutarium* Sw. was also collected by the author. *Aspidium cicutarium* Sw. is one of the commonest ferns of this area. This fern was found to be heavily infected during the months of August and September. The infected plants were particularly observed in the areas with heavy rainfall such as Khandala, Mahabaleshwar, etc. The fern *A. cicutarium* Sw. was found to be distorted with the swellings on the undersurface of the young fronds. The microscopic observation revealed that the pinnae were attacked by a fungus causing hypertrophy. The fungus was identified as a species of the genus *Herpobasidium,* a genus belonging to the order Auriculariales.

The study of literature on fungi of India, such as Butler and Bisby revised by Vasudeva[2], Vasudeva[12], Tandon and Sudhir Chandra[10], Tilak and Rao[11], Rangaswamy *et al.*[7] showed that the genus is so far unreported particularly from India and hence this makes the first report of the genus *Herpobasidium* from this country.

The genus *Herpobasidium* is a monotypic genus and was first described by Lind[6]. Lind while describing the new genus corrected Rostrup's *Gloeosporium filicum* Rostr. and Boudier's *Exobasidium brevieri* Boud. Both these were considered synonymous to the new taxon *Herpobasidium filicum* (Rostr.) Lind. Jackson[4] studied the development of the basidium and reported the occurrence of fungus from different parts of Canada in addition to earlier records from France, Norway, Sweden, Denmark and Russia by Saccardo[9]. This indicates that most of the reports of this fungus were from European and North American countries. The fungus is so far reported on species of *Aspidium, Phegopteris,* and *Cyclosorus.*

Young pinnae of *Aspidium cicutarium* Sw. were collected during the month of September 1969. They showed small, white, cushion-like growths on its undersurface (Fig. 1). These were bunches of hyphae spreading more or less parallel to the surface. The hyphae emerge through the stomata and spread over the surface forming mouldy over-growths. Mycelium inside the host is intercellular with characteristic coiled haustoria (Fig. 3) within the host cells. Basidia are formed at the tips of radially extended external hyphae. They are hyaline, clavate, and 30–40 × 6–8 μ in size. Basidia are usually two (Fig. 2) and rarely three-celled. Basidiospores are hyaline, oblong to oblong clavate, slightly curved and measure 10–13·5 × 5–6·25 μ. On the basis of these characters, the fungus was identified as *Herpobasidium filicum* (Rostr.) Lind.

The material is deposited in the Herbarium of Commonwealth Mycological Institute, Kew (No. 153125) and in the Herbarium, Botany Department, Poona University.



FIGS. 1–5. Figs. 1–3. *Herpobasidium filicum* (Rostr.) Lind on *Aspidium cicutarium* Sw. Fig. 1. Leaf of *Aspidium cicutarium* Sw. showing infection, × 1. Fig 2. Part of the T.S. of leaf of *A cicutarium* Sw. showing hyphae and basidia, × 800. Fig. 3 Coiled haustoria in a host cell, × 800. Figs. 4–5. *Herpobasidium filicum* (Rostr.) Lind on *Adiantum lunulatum* Burm. Fig. 4. Leaf of *A. lunulatum* Burm. showing infection × 3. Fig. 5. T. S, of the leaf of *A. lunulatum* Burm. showing emergence of hyphae through stomata, × 400.

A similar fungus was collected on fronds of *Adiantum lunulatum* Burm. from Khandala, Lonavla and Mahabaleshwar during the monsoon. The infected pinnae showed whitish growth on the undersurface (Figs. 4 and 5). The fungus is tentatively identified as *Herpobasidium filicum* (Rostr.) Lind. This makes an additional host record for the fungus.

Author is grateful to Dr. Punithalingam of the Commonwealth Mycological Institute, Kew, Surrey, England, for his help in confirming the identification. She is also thankful to Dr. M. S. Balakrishnan, Head of the Department of Botany, University of Poona, for laboratory facilities and to Dr. S. D. Patil for his help during the course of this work.

Botany Department, SUMATI A. JOSHI.
University of Poona,
Poona-7, India, *July* 5, 1971.

1. Boudier, M., *Bull., Soc. Myc., Fr.*, 1900, **16**, 15.
2. Butler and Bisby (revised by Vasudeva), *The Fungi of India*, I.C.A.R. Publ., 1960.
3. Couch, J. N., *Mycol.*, 1949, **41** (4), 427.
4. Jackson, H. S., *Ibid.*, 1935, 27 (6), 553.
5. Joshi, Sumati A., *M.V.M. Patrika*, 1968, **3** (2), 53.
6. Lind, *J. Arkiv. Fur. Botanik*, 1908, **78**, 1.
7. Rangaswamy, G., Sheshadri, V. S. and Lucy Chennamma, K. A., *Fungi of South India*, 1970.
8. Saccardo. P. A., *Sylloge Fungorum*, 1902, **16**, 198.
9. —, *Ibid*,, 1912, **21** 444.
10. Tandon, R. N. and Sudhir Chandra, *Supplement to the List of Indian Fungi*, 1957–62. Allahabad Univ. Studies, 1964.
11. Tilak, S. T. and Ramchandra Rao. 2nd *Supplement to the Fungi of India*, 1962-67, 1969.
12. Vasudeva, R. S., *Fungi of India, Supplement I*, I.C.A.R., Publ. 1962.

MODIFIED OPAQUE MAIZE FOR POSSIBIE APPLIED USE

ABSTRACT

The opaque-2 (o_2) gene has been incorporated by backcross method into eleven Indian inbreds with a view to develop a composite and hybrid varieties of high protein quality. The opaque-2 composite developed after two backcrosses and, subsequent selfing, showed variegation for normal sectors. The sectored types were classified into five distinct types (S_2–S_6). The lysine content of most of the sectored types was the same as in opaque-2 control, suggesting that the presence of normal (translucent) tissue may not alter the quality of protein. The two types of sectors S_5 (½ opaque : ½ normal) and S_6, similar in phenotype but with an 'opaque spot' on the top of the kernal, may be useful in breeding high protein quality maize with higher grain weight, better yield and normal texture.

THE opaque-2 gene in recessive condition boosts up the production of lysine by about 69–100% and tryptophane by about 66% over the normal maize. Feeding trials conducted with this maize on rats showed a weight gain of 3·6 times in 28 days over the control[1]. The six leading Indian hybrids were surveyed for some essential amino-acids and protein content[2]. It was found that although these hybrids are a little superior to some tested American varieties, the protein quality is still poor compared to opaque-2. A backcross breeding programme was undertaken in 1966 with eleven inbreds : CM 104, CM 105, CM 109, CM 110, CM 111, CM 201, CM 202, Eto-182, Eto-25 AF, Eto-297, and PTR-605 obtained from Maize Research Station, Amberpet, Hyderabad, to improve the protein quality of Indian maize. After two backcrosses with subsequent selfing, an yellow opaque-2 synthetic was developed from the opaque seed of the eleven inbred lines.

Though the yield of the synthetic was significantly higher than that of white opaque-2. however, the seed showed variegation for normal sectors. These were classified into five types of sectors as S_2, S_3, S_4, S_5 and S_6, depending on the area of the normal (translucent) tissue. Among these five, the S_5 and S_6 types have the maximum normal area than the other S-types. In S_5 the opaqueness is restricted to only half of the kernel, the other half being normal (translucent) which is similar to ½ opaque : ½ normal described earlier[3]. But in S_6, in addition to the basal half being opaque it also has an opaque spot on the top of the kernel (Fig. 1). The whole opaque seed (S_1) is used as control.

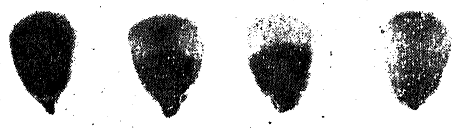


FIG. 1. The four types of kernels (from L to R). whole opaque (S_1). S_6, S_5 and normal tranlucent (viewed over a frosted glass illuminated from below).

The five types of sectored seeds were selfed along with the control S_1. The selfed S_1, S_2 and S_4 gave mostly S_1 kernels. However, S_3, S_5 and S_6 kernels upon selfing segregated for more than one S-type. The selfed S_5 gave four to eleven types of sectored seed including six new types whereas the S_6 gave mostly S_5 and S_6 types. The genetic behaviour of these sectors will be published elsewhere. The five types of sectored seed including control (S_1) were analysed for protein and lysine content at the National Institute of Nutrition, Hyderabad (Table I).

The thousand grain weight of control (non-opaque) is about 254·0 gm and American opaque-2 (white) is about 184·0 gm, whereas the synthetic yellow opaque-2 weighs about 215·0 gm. The S_5 and S_6 sectored types weigh 234·0 gm and 219·0 gm, respectively. Among the four opaque varieties, S_5 has the highest grain weight, S_6 being the next highest. This may be obviously due to the extent of translucent sector in opaque phenotype.

TABLE I

Protein and lysine content of sectored and yellow opaque-2

Types of sectors	Lysine (gm/100 gm protein)	Crude protein ($N \times 6 \cdot 25$)
S_1 (Control)	3·410	10·04
S_2	3·417	10·39
S_3	3·523	9·85
S_4	3·530	9·96
S_5	2·915	12·68
S_6	3·375	9·24

The present study suggests that lysine content of the opaque kernel is independent of the sector size. This is evident from S_3 and S_6 which have different sectored areas but almost the same lysine content. Among the two selfed S-types, S_5 and S_6, the latter segregated for less number of sector types than the former. In addition, the selfed S_5 also gave whole opaque seed (S_1) which is usually absent in S_6.

Considering the average grain weight, lysine content and the segregation for different sectored seed, the S_6 type seems to be more promising than either S_5 or S_1.

Dept. of Genetics, S. ANNAPURNA.
Osmania University, G. M. REDDY.
Hyderabad-7, Andhra Pradesh,
July 1, 1971.

---

1. Mertz, E. T., Vernon, D. C., Bates, L. S. and Nelson, O. E., *Science*, 1965, **149**, 1741.
2. Reddy, G. M. and Ramasastry, B. V., *Indian Jour. Genet. & Pl. Breeding*, 1967, **27**, 461.
3. Paez, A. V., Helm, J. L. and Zuber, M. S., *Crop Science*, 1969, **9**, 251.

TISSUE ANALYSIS, AS AN AID IN ASSESSING THE NITROGEN REQUIREMENTS OF COTTON (*GOSSYPIUM HIRSUTUM* L.)

TISSUE analysis is successfully used to determine the nutritional requirements in sugarcane[1] and pineapple[2]. Similar attempts have been made in cotton[3,4]. In assessing the nutritional requirements of cotton, the plant part to be assayed and age of the crop deserve careful study. Several workers[3,5,6] used nitrate in petioles of recently matured leaf as an index to evaluate nitrogen status of the plant and to predict the nitrogen need. The aim of the present study was to find the relationship between the N content of leaves at two growth stages and seed cotton yield and further to aid in nitrogen fertilization based on tissue test.

This experiment was conducted under irrigation at Agricultural Research Station, Arabhavi, for two seasons (1969–71). The soil was medium black with a pH of 8·2. The fertility status was low with respect to total N (0·036%) and available P (9·31 ppm). Split plot design was employed with three replications. Three varieties belonging to *G. hirsutum* L., *i.e.*, AS-6, MCU-5 and MCU-2 were in subplots while nitrogen and spacing combinations constituting 12 treatments were in main plots. The levels of N were 0, 30, 60 and 90 kg/ha and the spacing levels were 75 × 15, 75 × 25 and 75 × 35 cm. A basal dressing of 30 kg/ha each of P_2O_5 and K_2O was given. About 7–8 irrigations were given at intervals of 20–25 days and regular plant protection measures were taken. It was sown on 11th and 14th July in 1969 and 1970 seasons respectively. Recently matured leaves from the main stem (4th or 5th leaf from top) were taken at two growth stages, *viz.*, first at squaring, *i.e.*, 60–75 days after sowing and second at peak vegetative phase, *i.e.*, 100–110 days after sowing. About 50–100 leaves were dried in oven at 70° C. Nitrogen estimation was by the modified Kjeldahl method and per cent N was reported on dry weight basis.

The relationship between N content of recently matured leaves and seed cotton yield at peak vegetative phase is given by the regression equations along with the standard errors for slopes in **Fig. 1**.

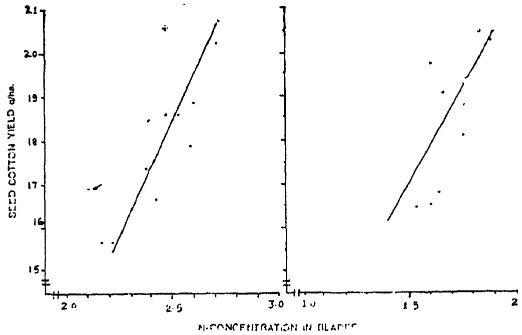


FIG. 1. Seed cotton yield *vs.* N% in leaves at peak vegetative phase *Left*—Season: 1969–70; $Y = -7 \cdot 7 + 10 \cdot 439 X$; *se* for *b*, $sb = 1 \cdot 858$; $r = 0 \cdot 781$ (significant at 1%); *Right*—Season: 1970–71; $Y = 3 \cdot 88 + 3 \cdot 742 X$; *se* for *b*, $sb = 0 \cdot 339$; $r = 0 \cdot 631$ at (significant 5%).

The results indicated that N content in leaves at peak vegetative stage could predict the nitrogen need as evidenced by the significant correlation coefficient. The regression coefficient or slope *b* in both seasons was highly significant suggesting that an increase in N content of leaves (within experimental values) tended to increase the yield. The coefficient of determination (r^2) for two seasons suggested that nearly 50–75% variation in yield can be attributed to N content in youngest mature leaves assayed at peak vegetative phase of crop. However, the N content of leaves at early stages, *i.e.*, at squaring, gave a poor prediction of yield as indicated by low and non-significant correlation coefficient ($r = 0{\cdot}458$).

It is inferred that the recommendations for N fertilizers can profitably be made on the basis of N content of youngest mature leaves at peak vegetative phase. To realise optimum yields, the N content at 90–100 days stage should be at least 1·8 to 2%[7]. Any drop in N content from this level would deem it necessary to fertilize the crop through foliage since soil applications may not be beneficial at the late stage of crop. It is concluded that tissue testing of annual crops will provide a useful technique in assessing the nutritional requirements of not only current crop but also for succeeding crops[8].

The financial assistance by the All-India Co-ordinated Cotton Improvement Project is gratefully acknowledged.

University of
Agricultural Sciences,
Bangalore, *July* 6, 1971.

GURURAJ HUNISGI.
B. N. PATIL.
N. S. PARAMESHWAR.

---

1. Clements, H. F., *Am. Inst. Biol. Sci. Publ*, Lord Baltimore Press, 1961, p. 131.
2. Stnford, W. G., *Better Crops with Plant Food*, Am. Potash Inst. May–June 1962 p. 8.
3. Joham, H. E. *Plant Physiol.*, 1952 **26**, 76.
4. Dastur, R. H., *Ind. Cotton Gr. Rev.*, 1959, **13**, 1.
5. Mackenzie, A. J., "Soil testing and plant analysis. *Plant Analysis*, Part II SSSA Special Publ. No. 2, 1967, p. 25.
6. Tucker, T. C., *Cotton Gin and Oil Press*, 1963, **64**, **36**.
7. Lockhardt, R. L., and Ensminger, L. E. "Changing patterns in fertilizer use" *Soil Sci. Soc. Am., U.S.A.*, 1968, p. 221.
8 Ulrich, A., *Ann. Rev. Plant. Physiol*, 1953, **3**, 207.

SOLAR RADIATION-INDUCED MUTATIONS IN *ASPERGILLUS*

MUTANTS artificially induced by various physical and chemical stimuli have been known for a long time in the genus *Aspergillus*[1,5,6]. Rai *et al.*[3] reported the natural occurrence of buff and tan mutants of *Aspergillus fumigatus* in Indian '*Usar*' (alkaline) soils and suggested that they may have arisen through the impact of rigorous physical conditions especially the intense solar radiations during summer months in the largely bare surface of this habitat. With this object in view, some experiments were carried out for the induction of mutations through the action of solar radiations in certain '*Usar*' soil Aspergilli and the results are reported in this paper.

Conidial suspensions of *Aspergillus clavatus, A. fumigatus, A. giganteus, A. nidulans, A. niger, A. sydowi, A. terreus* and *A. tubingensis* in sterilized water were separately pipetted in small quantities under aseptic conditions into a previously sterilized petridish. In addition, spore suspensions were also mixed in '*Usar*' and fertile soils separately for each species which along with the petridishes were directly kept in sunlight on bright clear sunny days during April–May. On every day, in the evening, appropriate quantities of suitably cooled Czapek-Dox agar were poured into these petridishes. The soils were, however, plated out on every alternate day using the Dilution- and Soil-plate methods. All the petridishes were incubated at 30° C. The resulting colonies were examined and those morphologically differing from the parent were isolated on agar slants. Control plates were also run simultaneously without exposing them to sunlight.

While not a single colony differing morphologically from the parent was isolated from the spore suspension mixed with soils, the plates involving the conidial suspensions kept under direct sunlight yielded some colonies differing from the type in case of *Aspergillus fumigatus* and *A. terreus* only.

The treatment of *Aspergillus fumigatus* conidia resulted into three types of colonies—one being the normal type, the other creamish in colour later identified as the albino or buff mutant of the species and, the third greyish-brown in colour. Microscopically the second one was exactly similar to that described by Rai *et al.*[3] from '*Usar*' soils while, the third one was identified as *A. fumigatus* var. *griseobrunneus*[4]. Both these forms were produced after one and three days treatment of the conidia respectively. However, in all the cases no colonies appeared after 5 days exposure of the conidial suspension to direct sunlight. In colonies conforming to the parent, there were some showing profuse proliferation of sterigmata into secondary and tertiary heads. It is noteworthy that such strains are also commonly isolated from '*Usar*' soils.

The plates involving *Aspergillus terreus* also showed three types of colonies—one resembling the parent, the second showing restricted growth and obviously nutritionally deficient and, the third showing abundant barren vesicles. Similar artificially induced mutants of this species were reported by Raper *et al.*[5]. Hollaender and Emmons[2] also reported the production of mutants in *A. terreus* by exposing spore suspension to direct sunlight.

Rai *et al.*[3] suggested that the natural occurrence of buff and tan mutants of *A. fumigatus* in *'Usar'* soils throws light on species evolution and also objected to the use of the term mutant for such isolates. On these grounds these so-called mutants were recognized as taxonomically valid units of the varietal rank[3,4]. The present work clearly demonstrates the possibility of the origin of such strains in a habitat like *'Usar'* soils that usually lie bare and receive high doses of solar radiations in the surface layers specially during the summers.

The authors are grateful to the U.S. PL 480 authorities for grant of financial assistance for a research project during the tenure of which this work was done.

Dept. of Botany,
Lucknow University,
Lucknow, India,
July 14, 1971.

J. N. RAI.
S. C. AGARWAL.

---

1. Hollaender, A., Raper, K. B. and Coghill, R. D. *Amer. J. Bot.*, 1945, **32**, 160.
2. — and Emmons, C. W. *Cold. Spring Harbor Symp. Quant. Biol.*, 1946, **11**, 78.
3. Rai, J. N., Tewari, J. P., Agarwal. S. C. and Wadhwani, K., *Can. J. Bot.*, 1968, **46**, 1330.
4. —, — and —, *Nova Hedwigia*, 1970 (in press).
5. Raper, K. B. Coghill, R. D. and Hollender A., *Amer. J. Bot.*, 1945, **32**, 165.
6. — and Fennell, D. I., *The Genus Aspergillus*, Williams and Wilkins Co., Baltimore, 1965.

INDUCED MUTATIONS IN A SWEET *CAPSULARIS* JUTE

ABSTRACT

After applying X-ray irradiations of 10–90 Kr to both dry and wet seeds of a new variety of sweet Tripura capsularis (*C. capsularis* L.), mutations, involving vegetative parts, were isolated which bred true in subsequent generations.

Out of the four selected mutations one showed better fibre qualities approaching to the olitorius (high land jute), *C. olitorius*.

This promising mutant, also having high node number and basal diameter, is a good breeding material for production of a superior *capsularis* jute.

FOR breeding improved varieties of jute emphasis is being given on selection of variants associated with tallness, unbranched nature of stem, higher basal diameter with well-formed periderm, larger number of internodes and late flowering, besides, good qualities of fibre. All the recommended varieties of the two species of jute have big petiolated leaves arranged on an alternate phyllotaxy. In normal cultivation practices the spaces given between the plants and rows are deliberately cut down to induce the plants to grow taller, inhibiting lateral branching.

Jute is a predominantly self-fertilized crop and the two cultivated species do not hybridize. Production of improved types have naturally been restricted to intervarietal crosses and selection of suitable recombinant types, except, of course, picking up of a chance natural mutant. In order to obtain wider genetic variability, particularly for selection of better plant types, plant breeders in recent years are trying to effect interspecific hybridization of the two species and also by scattering genetic variability within the species through irradiation. During the course of our investigation in jute, a new variety "Tripura Capsularis" was considered a suitable material for such experimental studies. While the results about interspecific hybridization using this species have been reported earlier by Bhaduri and Bairagi[1,2], results obtained through X-ray irradiation in this variety are reported here. From the present investigation mutant lines showing desirable plant types such as tall, unbranched stem with smaller adpressed leaves and suppressed lateral branches, shorter petioles and better fibre quality than that of normal C. *capsularis* L. have been isolated. In recent years a number of workers have succeeded in isolating diverse kinds of mutations from their radiated progenies[4-7,9,12,14,15]; but from the available literature it appears that a similar plant type reported here has not been isolated so far.

In the present set of experiments, X-ray irradiations of 10 Kr to 90 Kr were applied to one hundred dry as well as wet seeds for each dose. The LD_{50} and LD_{100} values were scored of the successful plants that stood up to the age of 30 days. These are 30 Kr (dry seed treatments) and 20 Kr (wet seed treatments) for the LD_{50}, and 90 Kr and 80 Kr (dry and wet seed treatments) for the LD_{100} respectively. Variations induced in different plant parts in the X_1 generation could be broadly classified under two heads: (*i*) variations in the early growth phase of the plants, such as chlorophyll variation, fasciations of stems, leaf abnormalities, etc., and (*ii*) variations at later stages affecting floral parts, maturity, fertility, etc.

Scoring of induced genetic variability in the X_2 generation raised from selfed seeds of individual X_1 plants was based on characters like stem variation, leaf variation, flower variation, pod variation, seed variation, etc. Table I reveals the spectrum and frequency of variations in the X_2 generation.

TABLE I

Mutation frequencies in the X_2 progenies of X-ray irradiated dry (D) and wet (W) seeds

X-ray doses in Kr*	% of mutations scored	
	D	W
10	1·6	1·7
20	1·5	2·8
30	3·4	6·2
40	5·4	3·1
50	2·8	2·1
60	2·0	1·9
70	1·8	1·7
80	1·6	0
90	0	0

* Mutation frequencies calculated on the basis of total discontinuous variations recorded in the population in contrast to the control population.

TABLE II

Comparison of physical measurements and quality-test (mean values) of fibres of the four classes of C. capsularis *(Tripura) against control D 154 and JRO 632*

Description of the plant type	Physical measurements				Quality tests of the fibre			
	Height in cm	Apical branch No.	Node No.	Basal dia (cm)	Yarn tenacity r. (g/tex)	Fibre tenacity F (g/tex)	Fibre fineness (tex)	Density g/cc
Control ..	184·00	3	34	1·07	9·1	15·4	2·4	1·482
Type I ..	302·00	3	45	1·17	8·5	13·5	2·8	1·480
,, II ..	311·00	3	49	1·29	11·9	23·2	2·5	1·490
,, III ..	325·00	3	64	1·69	10·1	19·4	2·2	1·490
,, IV ..	338·00	3	70	1·99	12·5	25·1	2·4	1·484
D 154 ..	357·00	3	68	1·98	10·6	20·1	2·5	1·374
JRO 632 ..	399·00	3	74	2·10	12·3	23·8	2·4	1·404

The X_3 populations were classified into two classes, tall plants above 2·50 m and the shorter plants below 1·20 m. Largest number of tall plants were recorded at 30 Kr wet and 40 Kr dry seed treatments respectively. These tall X_3 plants were further classified into four distinct classes. These are: Class (I), Tall plants, non-branching type, bearing single and broad leaf with long internode. Class (II), Tall plants with top branching having single and broad leaf. Class (III) and Class (IV), Tall plants with shorter internodes and adpressed leaves with alternate phyllotaxy. The latter are of two types: (*a*) one with distinct top branching habit and the other, (*b*) unbranched even at the top region.

To confirm the true breeding characters of the four classes of plant types, a X generation was raised and the qualities of fibre were analysed on single plant basis. In Table II, the fibre-quality and other characters in contrast to the standard cultivated jute species have been presented. It will be apparent from these data that the mutant type IV is an improved and promising capsularis type and comparable to the standard olitorius type like JRO 632.

The adpressed leaf mutant shows superior fibre quality than that of normal capsularis. If it is found to be adaptable to low land conditions and not much susceptible to diseases, then this variety can be grown extensively as a superior variety. Regarding its performance to closer spacing, response to higher fertiliser doses, and wider adaptability to different soil conditions experiments are now under way.

The quality testing of jute was done at the JTRI, Tellygunge, Calcutta, facilities for which were kindly granted by the Director, Dr. S. B. Bandopadhya.

Dept. of Botany, T. K. MAJUMDAR.
Burdwan University, P. N. BHADURI.
Burdwan, West Bengal, India, *July* 7, 1971.

1. Bhaduri. P. N. and Bairagi, P., *Sci. and Cult.*, 1968, **34**, 355.
2. — and —, *Ibid.*, 1969, **35**, 105.
3. — and Chakravarty. A. K., *Ibid.*, 1948, **14**, 212.
4. Basak, S. L. and Biswas, P. K., *J. of Cytology*, 1968, **33** (1), 50.
5. Basu, R. K., *Trans. Bose. Res. Inst.*, 1962 *a*, **25**, 57.
6. Datta, R. M., *Der Zuchter*, 1963, Band 33, Heft 1, 17.
7. Jacob, K. T., *Trans. Bose Res. Inst.*, 1949–50. **18**, 23,
8. *Jute Bull.*, 1964, **27**, 180.
9. Kundu, B. C., *Sci. and Cult.*, 1944, **9**, 559.
10. —, *Proc. Nat. Inst. Sci. India*, 1946, **12**, 181.
11. —, *Jute in India*, I.C.A.R., A Monograph, 1961.
12. —, Ghosh, K. and Sarma, M. S., *Genetica*, 1961 **11**, 51.
13. Nakajima, G., *Japan J. Genet.*, 1949, **2**, 121.
14. Rao, K. R., Sanyal, A. T. and Dutta, J., *Sci. and Cult.*, 1944, **10**, 86.
15. Swaminathan, M. S., *J. Sci. and Ind. Res.*, 1964, **23**, 455.

REVIEWS AND NOTICES OF BOOKS

Flame Emission and Atomic Absorption Spectrometry: Volume 2—Components and Techniques. Edited by John A. Dean and Theodore C. Rains. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y. 10016), 1971. Pp. xiv + 362. Price $ 22.75.

This 3-volume set of Flame Emission and Atomic Absorption Spectrometry is intended to provide a source of theoretical and practical analytical information for workers concerned with flame spectrometry methods. The chapters are written by authoritative working scientists drawn from all over the world.

The basic principles of flame emission and atomic absorption spectrometry were the topics discussed in Volume 1. The second volume of this triology under review is concerned with the practice and techniques of flame methods. Eleven authors have contributed to the thirteen chapters of the book.

The introductory chapter is a general one which covers a number of miscellaneous topics on the subject that are not treated in subsequent chapters. The next five chapters are concerned with Light Sources, Burners and Nebulizers, Nonflame Absorption Devices, The Optical Train and Electronics. Instrument Operation dealing with procedures and precautions is the subject of the seventh chapter. In all these chapters the development includes theoretical and practical aspects as well. The subject of Chapter 8 is Atomic Fluorescence Spectrometry, while Chapter 9 deals with Commercial Instruments, In Chapters 10 through 13 are handled the problems of sample preparation and separation methods, trace analysis and micromethods, evaluation of data, and preparation and storage of stock solutions.

A. S. G.

Real Analysis. By N. B. Haaser and J. A. Sullivan. (Van Nostrand Reinhold Company, 450, West, 33rd Street, New York, N.Y. 10001), 1971. Pp. ix + 341. Price $ 11.95.

The book in the University Series in Mathematics is a text for first course in abstract analysis useful for under-graduates as well as graduate students. It provides a smooth transition from calculus to more advanced work in analysis.

The first three preliminary chapters on Sets and Relations, the Real Number System, and Linear Spaces provide a foundation for what follows. These deal with Metric Spaces in which the properties of completeness, compactness, connectedness and continuity functions are studied. In the study of abstract spaces normed linear spaces which combine the properties of linear spaces and metric spaces are considered. Then there are chapters on the fundamental theorems of calculus, the Stieltjes integrals, and inner product spaces and orthogonal bases for such spaces. Finally pointwise convergence of Fourier series and Fourier integrals is discussed.

The book is designed to suit the recommendations of the Committee on the Under-graduate Programme in Mathematics of the Mathematical Association of America for the topic Real Analysis.

A. S. G.

Annual Review of Medicine (Vol. 22). Editors: C. Arthur and C. DeGraff. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1971. Pp. vii + 447. Price U.S.A. $ 10.00; Foreign $ 10.50.

As in the case of previous issues, the present volume (22) of *Annual Reviews of Medicine* contains review articles which treat in depth various areas in which there have been remarkable recent advances in information and insight. A wide range of subject-matter is covered, and the topics have been selected both for their general interest and for their intellectual and scientific importance. Some chapters, as the one on Myasthenia Gravis and the Thymus, describe the culmination of many years of research by many investigators. Others, as the one on antigenic reversion in human cancer, describe work which is more recent in its origin and development.

The contents of this volume are as follows: "Proinsulin", by A. H. Rubenstein and D. F. Steiner; "Malabsorption due to Lymphomatous Disease", by B. Ramot; "Superinfection in Lymphoreticular Diseases", by Z. A. McGee, W. Schaffner and M. G. Koenig; "Intraleukocytic Microbicidal Defects", by S. J. Klebanoff; "Kinins in Human Disease", by D. L. Wilhelm; "Antigenic Reversion in Human Cancer", by P. Gold; "Senile Macular Degeneration", by P.

Henkind; "Optic Atrophy and Neurosyphilis", by J. L. Smith and C. W. Israel; "Myasthenia Gravis and the Thymus", by G. Goldstein; "Alcoholic Myopathy", by G. T. Perkoff; "Fetal Indications for Therapeutic Abortion", by A. C. Barnes; "Antibody Variability", by R. Pink, An-Chuan Wang and H. H. Fudenberg; "Proliferation of Myeloid Cells", by S. Perry; "Lymphocyte Physiology", by J. A. Mills and S. R. Cooperband; "Abnormal Hemoglobins with High and Low Oxygen Affinity", by S. Stamatoyannopoulos, A. J. Bellingham, C. Lenfant and C. A. Finch; "Inducible Metabolic Abnormalities During Development of Obesity", by E. A. H. Sims, E. S. Horton and L. B. Salans; "Smallpox and Smallpox Vaccination Policy", by J. M. Lane, J. D. Millar and J. M. Neff; "Use of Physicians' Assistants in the Delivery of Medical Care", by E. A. Stead Jr.; "Alpha, Antitrypsin Deficiency and Pulmonary Emphysema", by C. A. Guenter, M. H. Welch and J. F. Hammersten; "Clinical Application of Continuous Monitoring of Respiratory Failure", by K. R. Tantum and R. D. Dripps; Metabolic Modification of Parkinson's Disease and of Chronic Manganese Poisoning", by G. C. Cotzias, P. S. Papavasiliou, J. Ginos, A. Steck and S. Duby; "Papillary Muscle Dysfunction in Coronary (Ischemic) Heart Disease", by N. P. DePasquale and G. E. Burch; "Late Complications of Heart Valve Replacement", by A. J. Kaltman; "Abnormalities in Cardiac Contractility Associated with Localized Myocardial Damage", by A. C. Fox; "Structure and Function of the Myofibrillar Contractile Proteins", by P. Dreizen; and "Intestinal Digestion and Maldigestion of Dietary Carbohydrates", by G. M. Gray. A. S. G.

Quantum Particle Dynamics. By P. G. Puranik. (S. Chand & Co,, P. Ltd., Ram Nagar, New Delhi-55), Pp. xi + 315. Price Rs. 25·00.

The present publication is the result of the author's lectures on the subject for over two decades to the Master's degree classes at the Osmania University. Starting with the basic concepts of Special Relativity, the treatment covers non-relativistic quantum mechanics, and includes high energy electromagnetic events and nuclear forces.

The book has, in common with such publications based on lecture notes, the usefulness such as providing a guide to teachers to base their lectures on, and a rote to students to answer examination papers, as well as the disadvantages, such as general incoherence in the development of the subject and lack of elucidation at particular points which an average student reader would appreciate. However, references at the end of each chapter to more standard text-books will supply him the need. A. S. G.

Nonlinear Effects in Plasma. By V. N. Tsytovich. (Plenum Press, New York and London), 1970. Pp. xviii + 332. Price $ 25.00.

This is the English translation of the original Russian text first published in 1967, but which has been corrected by the author for this edition. In this book the author unravels the complexities usually associated with nonlinear effects in plasma and shows that it is possible to formulate nonlinear theory in fairly general terms.

Basically, the author's approach is to show that Einstein's familiar concept of induced emission and absorption of waves is entirely consistent with results derived rigorously for interactions in weakly turbulent plasma. These results are first derived by means of conventional electrodynamics, and their limits of validity are discussed in detail. The physics is essentially classical, but a quantum approach used for convenience, and the concepts of energy and momentum conservation are invoked extensively, as is the useful analogy between an unstable plasma situation and a "negative-temperature" system.

In addition to presenting fundamental physical concepts and methods for estimating nonlinear interaction, the book discusses in the final chapter many current developments in this field of research. A. S. G.

Cedrus (Botanical Monograph No. 5). By P. Maheshwari and Chhaya Biswas. (Council of Scientific and Industrial Research, Hillside Road, New Delhi-12), Pp. vi + 115, Price Rs. 24·00 or 48 *sh.* or $ 8.00.

Cedrus deodara, commonly known as deodar, is one of the most valuable timbers. It is the strongest of the Indian coniferous woods and deodar timber is widely used as a substitute for teak and sal. Its primary use in India is for railway sleepers. *Cedrus* has attracted the attention of Indian botanist for many years, yet a co-ordinated account of the work done in India on the botany of this important wood in a book form which will be useful to the student and the layman alike has been wanting. The present monograph by (Late) Prof. P. Maheshwari and his coworker fulfils this need.

The monograph deals with the distribution, morphology and anatomy, embryology, life-cycle, natural and artificial regeneration, fungal diseases, and the economic importance of this important conifer wood. The book is liberally illustrated. There are 55 figures which include many halftone plates. A. S. G.

Researches on Living Pteridophytes in India, Burma and Ceylon. By N. P. Chowdhury. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), 1971. Pp. 80. Price Rs. 22·00.

This little book is a critical compendium of information carefully sifted from the wide range of pteridological researches carried out in India, Burma and Ceylon during the last more than a century. Very recent researches in this field are included as appendices. A carefully prepared bibliography adds to the usefulness of the book to students and research workers. The book contains five plates on *Marsilia*.

A. S. G.

Pest Control in Bananas—*PANS Manual No.* 1. (New Edition). Edited by Susan D. Feakin. (PANS, 56, Grays Inn Road, London, WCIX Blu, England), 1971. Pp. iii + 128. Price £ 0.42.

To meet the demand for the Manual on *Bananas*, the first edition of which was printed in 1966 and distributed or sold out by 1968, PANS have decided to re-issue the same as a completely new edition. The whole Manual has been re-written and new information collected to give banana growers as up-to-date a picture as possible of the latest developments in all aspects of pest control in Bananas.

Copies of this Manual are available from the address above and are supplied free of charge to workers in government service in countries eligible for British Aid. A. S. G.

A Glossary of Mycology (Revised Edition). By Walter H. Snell and Esther A. Dick. (Distributed by Oxford University Press, Oxford House, Mount Road, Madras-6), 1971. Pp. xxxii + 181. Price $6.50 (Rs. 48·75).

This book is an indispensable addition to all scientific libraries, and every mycologist should have it on his bookshelf.

The first edition of the book, published in 1957, found a ready welcome by working mycologists, and there is no doubt that this second edition, which brings the glossary of terms uptodate and includes many additional terms and revised definitions, will find an equally ready reception.

The Glossary contains more than 7,000 terms of mycological importance, their derivations, their definitions and meanings which are as accurate and precise as possible under the circumstances. Terms used in the field of medical mycology and antibiotics, and colour terms as per *Repertoire de Couleurs* are also included.

At the beginning of the book there are 15 plates, of excellent diagrammatic line drawings which illustrate 191 of the terms referring to pileus, gills, stipe, volva, fructifications, aecia, setae, spores, etc.

Besides its essential use by mycologists this Glossary should find a place on a science editor's desk. A. S. G.

Books Received

Solid-State Physics Literature Guides (Vol. I) —*Ferroclectric Materials and Ferroeletricity*. Compiled by T. F. Connolly and E. Turner. (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xi + 685. Price $ 35.00.

Flat Glass Technology. By R. Persson. (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1969. Pp. ix + 167. Price $ 12.50.

Geostatistics A Colloquium. Edited by D. F. Merriam. (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xiii + 177. Price $ 10.00.

Heterogeneous Kinetics at Elevated Temperatures. Edited by G. R. Belton and W. L. Worrell. (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. viii + 532. Price $ 27.50.

HMO Energy Characteristics.. By R. Zahradnik and J. Pancir. (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1971. Pp. v + 102. Price $ 12.00.

Topics in Plasma Diagnostics. By T. M. Podgornyi. (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1971. Pp. xiv + 214. Price $ 22.50.

Yield Point Phenomena in Metals and Alloys. By E. O. Hall. (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1971. Pp. viii + 296. Price $ 16.00.

Blood Cells as a Tissue. Edited by W. L. Holmes. (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xi + 371. Price $ 15.00.

3127-71. **Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.**

ENCYSTMENT OF AMOEBAE : AN EXAMPLE OF SINGLE CELL DIFFERENTIATION*

C. R. KRISHNA MURTI
Central Drug Research Institute, Lucknow

ENCYSTMENT AND AMOEBIASIS

MANY protozoa undergo encystation—a process by which motile amoebae lose their characteristic pseudopoidal movement and become covered by a protective sheath made up of a double layered wall. The resulting cysts are immotile and metabolically inert but are inherently capable of resuming trophic or vegetative existence by shedding the cyst coat when conditions are favourable for excystment. Although encystation is only a defensive posture adopted by the cell to encounter the stress imposed by a hostile environment, transformation of the trophic amoeba to the cystic form and of the viable cyst back to the trophozoite involves cellular differentiation[1-4].

The elucidation of this process of differentiation at the molecular level besides its intrinsic academic interest is of vital importance in the successful eradication of amoebiasis. *Entamoeba histolytica* is the causative agent incriminated in amoebic dysentery, amoebic colitis and amoebic appendicitis. Attempts to demonstrate an association of the pathogenicity of *E. histolytica* with toxins or invasive enzymes elaborated by it have so far been futile and as such there is no rational experimental basis today for initiating a programme of passive or active immunization against the disease[5]. Coexisting with the commensal bacterial flora of the human gut, *E. histolytica* multplies vigorously and undergoes encystment and excystment. Ulceration in the gut wall and abscess formation in the liver are brought about by the multiplication and erosive action of the trophic form of the pathogen. The transmission of parasitic *E. histolytica* from one host to another is, however, mediated by the cysts. Human carriers of *E. histolytica* may not exhibit overt symptoms of the disease and yet can pass out viable cysts of the parasite. Multiplication of the trophic form can be arrested by treatment with enterovioform or nitroimidazole derivatives which act in the bowel lumen, antibiotics which eliminate the associate bacteria and render the amoeba innocuous and chloroquine which brings about the remission of liver abscess. The cysts, on the other hand, are impermeable to these agents. The urgent need for the discovery of potent cysticidal agents has, therefore, been repeatedly emphasized by the Expert Study Group of WHO[6]. A rational design of cysticidal agents can be attempted only after the chemical composition of the cyst wall and the molecular biology of encystment are described in precise terms.

In an extensive review on the morphology, formation and development of cysts of Entamoeba, McConnachie[7] has drawn attention to the inadequacies in the currently available information on the biochemistry of encystment. The environment of the human gut and its native microflora appear to be essential for *E. histolytica* to encyst[8]. The pathogen can, however, form cysts outside the gut in monoaxenic cultures. Yet, attempts to produce *in vitro* cysts with axenically grown *E. histolytica* have been hitherto unsuccessful. What is the nature of the triggering agent in the human gut that signals the amoebae to encyst ? Is encystment only a defence measure for survival against a hostile environment ? Are the drastic metabolic changes that occur concurrently with the morphological transformation during encystment, controlled by the genome of the amoeba ? As the molecular events enacted by *E. histolytica* during encystment have not been completely mapped and quantitated, the above questions have remained unanswered.

In contrast to the behaviour of *E. histolytica*, free living pathogenic soil amoebae such as *Acanthamoeba* or *Hartmannella* can be induced to undergo encystation under strictly axenic conditions. Such systems, obviously, provide a useful model for the study of the mechanism of encystment and have been gainfully employed in some recent investigations. The biochemistry of the encystment of *Acanthamoeba* sp. has been discussed in some detail

---

*** Communication No. 1675 from the Central Drug Research Institute, Lucknow. based partly on a talk given to the participants of the Summer Institute of Advanced Biology at the Department of Biological Sciences, Madurai University, Madurai, on June 28, 1971.**

by Neff and Neff[9]. Emphasising the striking resemblance of encystment to certain phases of embryonic differentiation, they conclude that during encystation amoebae do not divide but only go through a period of induction followed by the morphological changes leading ultimately to the formation of the cyst. In the process, however, new types of macromolecules appear, the emergence of which is blocked by inhibitors of the synthesis of RNA and protein.

ENCYSTMENT OF AXENICALLY GROWN *H. culbertsoni*

As part of a research project on the chemotherapy of amoebiasis, some aspects of the encystment of a free living soil amoeba identified by Singh and Das[10] as *Hartmannella culbertsoni* have been investigated by the author and his associates. The aim of this brief review is to highlight some of the pertinent observations of this study.

H. culbertsoni can be grown axenically in a proteose-peptone-tryptone medium. On transferring six days old cultures of *H. culbertsoni* to replacement media no encystment is noticed. Nor does the incorporation in the growth medium of mitomycin C, actinomycin D, cycloheximide, *p*-fluorophenylalanine or azaadenine at later phases of growth lead to encystation. However, on incubating six days old amoebae on non-nutrient agar plates containing 10 mM NaCl, 15 mM $MgCl_2$ and 20 mM taurine ($NH_2 . CH_2 . CH_2 . SO_3$) 80–90% of the trophozoites are transformed into viable double walled cysts in the course of 72–96 hrs. The idea of using taurine, betaine, adrenaline or noradrenaline, all derivatives of amino-acids, suggested itself from the following earlier observations: (*i*) free living amoebae undergo encystation in the presence of bacteria[11] and (*ii*) the colon where *E. histolytica* normally encysts is rich in amino-acid degradation products arising out of bacterial metabolism. Fortunately this surmise turned out to be correct and after a number of trials using adrenaline, noradrenaline, betaine, taurine or creatinine, the above-mentioned combination of Mg^{2+} and taurine in saline has been found to be optimal for the *in vitro* encystment of *H. culbertsoni*[12].

Periodic microscopic examination of the amoebae exposed to the above encysting medium reveals typical morphological changes such as the withdrawal of the pseudopodia, rounding up of the amoebae, shrinkage in cell size and the final building up of a double layered cyst wall. When transferred to the growth medium, viable cysts obtained by this procedure can excyst. The trophozoites formed thus could once again be transformed into viable cysts by exposing them to the combined action of Mg^{2+} and taurine and the cycle of differentiation repeated as many times as one wished. Since *H. culbertsoni* undergoes encystation readily in the presence of bacteria[11], every possible care has to be taken to exclude bacteria in the *in vitro* induction of encystation of the amoebae by Mg^{2+} and taurine. Mitomycin C, actinomycin D and cycloheximide are all uniformly effective in appropriate concentration in arresting encystment. It is evident, therefore, that information transfer is involved in the induction of encystation and if a break has to be applied to the underlying process of differentiation it must be at one of the steps of genetic expression[12].

The exposure to Mg^{2+} and taurine leads to changes in the internal milieu of the amoebae directed by a regulatory mechanism under genetic control. Formation of the cyst wall is the ultimate morphological manifestation of the totality of such changes. It is not necessary that the amoebae have to be continuously exposed to Mg^{2+} and taurine to be "turned on" for differentiation. Encounter with these two agents for a period of six hours initially is all that is required. After this, when they are transferred to non-nutrient agar containing only 10 mM NaCl, the same degree of encystment ensues in 72–96 hrs. as given by keeping the amoeba throughout the period in the encysting medium. The action of Mg^{2+} appears to be related to osmotic effects resulting in the leakage of cellular constituents and is somewhat analogous to what has been reported to occur in the slime mould differentiating under the action of this cation. The exit of essential metabolites from the cytoplasm can presumably lead to dormancy. Alternatively, Mg^{2+} may be playing a role in specifically activating or stabilizing the ribosomes on which the enzymes required for the manufacture of cyst wall constituents are assembled as a result of translation. The mechanism of triggering effected by Mg^{2+} and taurine remains to be studied.

ROLE OF CYCLIC AMP IN ENCYSTMENT

Acrasin, a factor required for the aggregation of the slime mould *Dictyostetium discodium*, has now been identified as cyclic AMP[14-21]. For the slime mould to differentiate, aggregation and formation of clumps appear to be an essential preliminary step. Such aggregation is stimulated by c-AMP and, furthermore, strains or species of amoebae which excrete phosphodiesterase into the medium do not aggregate as readily as those which do not excrete the enzyme. Thus, the relative concentrations of phosphodiesterase and cyclic AMP in the periphery of the amoebae seem to exert a regulatory influence by preventing or facilitating aggregation[22-23]. Although other nucleotides have the same effect on the morphogenesis of *D. discosdium*, c-AMP is perhaps the natural activator. It is relevant in this context to mention that c-AMP also influences the morphological transformation of mammalian cells such as normal fibroblasts[24] or Chinese hamster cells[25]. The action again of c-AMP in regulating enzyme induction in bacteria is well documented[25-31]. Already established as the chemical mediator of hormonal action in both animals[32] and plants[33,34], cyclic AMP, among a multiplicity of functions, seems to be involved in the metabolic regulation and differentiation of unicellular organisms as well.

By experiments designed to explore whether the Mg^{2+} and taurine induced encystation of *H. culbertsoni* is mediated by c-AMP, Raizada and Krishna Murti have been able to show that c-AMP mimicks the role of Mg^{2+} and taurine in the transformation of trophozoites to cysts. Furthermore, trophozoites exposed to Mg^{2+} and taurine in the non-nutrient medium synthesize three to four times the amount of c-AMP as do the control trophozoites. While the encystation inducing action of c-AMP is shared by theophylline—an inhibitor of phosphodiesterase, 5′ or 3′ AMP do not exhibit this property but ADP stimulates encystation to some extent. Amoebae exposed to Mg^{2+} and taurine as well as the medium in which they are encysting show decreased levels of phosphodiesterase activity. The above evidence leads to the inescapable conclusion that c-AMP is perhaps the agent that triggers the molecular events that lead to the encystation of *H. culbertsoni*[35].

Since cyclic AMP mediated cellular reactions require preactivation of a membrane bound adenylcyclase, it is of interest to know whether taurine is picked up by the membranes of *H. culbertsoni*. By measuring the incorporation of taurine-S^{35} on the membrane system of trophozoites exposed to the encysting medium, one finds that Mg^{2+} ions do indeed stimulate the specific binding of taurine to the membranes[36]. On the basis of this observation it may be inferred that after binding of taurine to the membranes, particulate adenyl cyclase is activated leading in its turn to a synthesis of cyclic AMP. The nature of the specific macromolecule to which c-AMP is bound remains to be uncovered. Modulation of a protein, especially an enzyme with a sub-unit structure to an altered conformation, is now accepted as the *modus operandi* of c-AMP.

MACROMOLECULAR CHANGES DURING ENCYSTMENT

The morphological changes leading to the differentiation of trophozoites to cysts are accompanied by alterations in the chemical composition of the cellular milieu, enzyme profile and serological character of the trophozoites. The most dramatic change that takes place during the differentiation is the switching over of the metabolism of the trophozoites from aerobiosis to anaerobiosis ending up in a cellular form almost inert metabolically. Soluble carbohydrates, phosphates, RNA, DNA and proteins decrease in content whereas the concentration per unit mass of complex carbohydrates such as cellulose and mucopolysaccharides increases. The activity of dehydrogenases mediating the aerobic degradation of glucose carbon for energy production gradually decreases. In contrast, enzymes required for the building up of polymer constituents or cyst wall such as mucopolysaccharides and cellulose increase in activity. Synthesis of cellulose as measured by the incorporation of glucose-U-C^{14} into a β-linked polymer of glucose (as evident from its susceptibility to cellulase) is stimulated nearly thirty-fold during the first twenty-four hours of exposure of the trophozoites to the encystation medium. The induction of these enzymes is also blocked by actinomycin D and cycloheximide suggesting that their synthesis involves transcription and translation[37].

Concurrently with the above biochemical changes, the encysting cells acquire new serological characters. The precipitin type of antigens specific to cysts are visualized on Ouchterlony plates only after their exposure to trypsin whereas the trophic antigens that readily show precipitin lines with their homologous antiserum are inactivated by trypsin. Cystic antigens fix guinea-pig complement both specifically (in the presence of homologous anti-sera) and non-specifically. The specific complement fixation by cystic antigens is not affected by trypsin whereas the specific fixation of guinea-pig complement by trophic antigens is abolished by trypsin. Furthermore, the non-specific fixation of complement, a property exhibited only by cysts, is inhibited by cellulase^{38}.

Outlook for the Future

The single cell differentiation bringing about encystment and excystment of *Hartmannella* is diagrammatically represented in Fig. 1.

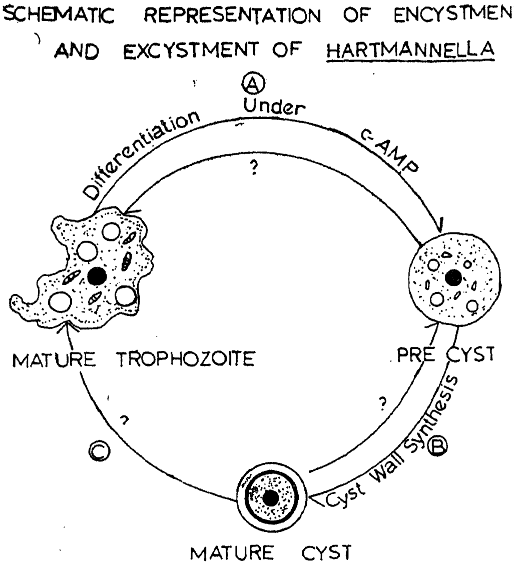


Fig. 1

Events during Step A: 1. Binding of taurine to membrane and activation of adenyl cyclase and increase in the concentration of intracellular c-AMP. 2. Massive degradation of reserve materials and shrinkage of mitochondria. 3. Shift from aerobiosis to anaerobiosis.

Events during Step B: 1. Induction of enzymes needed for the synthesis of cellulose and mucopolysaccharide. 2. Disappearance of mitochondrial activity. 3. Attainment of dormancy.

Events during Step C: 1. Imbibition of water. 2. Activation of trophozoites. 3. Shedding of outer cyst coat. 4. Emergence of active trophozoite.

On morphological evidence, it can be assumed that the events from A to B through precyst stage are reversible. Reversibility of the biochemical events has, however, not been experimentally established.

The induction stage in the encystment of *H. culbertsoni* involves the shutting off of aerobic metabolism and a loss in respiratory activity with attendant destruction or shrinkage in the size of the mitochondrial apparatus. Entamoeba, in contrast, is a typical anaerobe and its very survival depends upon the maintenance of strict anaerobic conditions. Though environmental factors, particularly nutrition and redox potentials, have been considered to be important in bringing about the encystation of Entamoeba$^{39-41}$, metabolic changes during encystment have not been mapped in any detail. If encystation is indeed preceded by cessation of growth, starvation and massive breakdown of reserve food materials, the attendant degradative changes may be expected to be favoured by anaerobic rather than aerobic conditions. It may well be that for Entamoeba to encyst only an induction phase is required for the elaboration of the enzymes mediating cyst wall synthesis and no substantial change in the energetics of the cell. Cysts of *Entamoeba* have been reported to survive even under aerobic conditions depending upon the amount of glycogen and chromatoid body available in the cytoplasm. This would imply that in the encystment of *E. histolytica* there may be a switchover from anaerobiosis to aerobiosis, the reverse of what is occurring in encysting aerobic *Hartmannella*. Nonetheless, with the knowledge available of such induction in *H. culbertsoni*, it should be relatively easy now to demonstrate the synthesis of mucopolysaccharides and cellulose in encysting *E. histolytica*.

Axenically grown cultures of pathogenic strains of *E. histolytica* have not so far been transformed *in vitro* into viable cysts. Axenically grown *E. histolytica* are also relatively non-pathogenic to experimental animals. In contrast, monoaxenically or diaxenically grown cultures of *E. histolytica* are very virulent and also undergo encystation both *in vivo* and *in vitro*. The significance of this difference in behaviour between axenically grown and non-axenically grown *E. histolytica* remains to be elucidated. Avirulent laboratory cultures of *E. histolytica* readily become virulent on animal passage or on repeated subculturing in media rich in cholesterol^{42,43}. A study of the cholesterol metabolism of E. *histolytica* in axenic cultures may help in understanding the change of virulence to avirulence. Detailed investigations on the synthesis and degradation of macromolecules by the sequential creation and destruction of cyclic AMP or other regulatory molecules have to be conducted. The indentification of factors secreted by bacteria that apparently bring about the encystation of *E. histolytica* in the human gut would appear to be yet another fruitful line of work.

The evidence adduced so far on the biochemistry of encystment using free living amoeba as model suggests that the synthesis of cellulose synthetase or mucopolysaccharide synthetase are coded by new species of *m*RNA's. Almost a similar situation is encountered in the sporulation of micro-organisms. The imposition of dormancy over a vegetative phase characteristic of amoebic encystment or bacterial sporulation is perhaps under the control of a unitary regulatory mechanism involving cyclic nucleotides. In the light of this, amoebic excystment, or for that matter, germination of a bacterial spore, may be controlled by the opposite counterpart of the regulatory mechanism operating encystment or sporulation. The molecular biology of encystment and excystment is thus two sides of the same coin, namely, a process of a single cell differentiation.

---

1. Trager, W., *J. Protozool.*, 1963, **14**, 114.
2. Willmer, E. N., *Symp Soc. exptl. Biol.*, 1963, **17**, 215.
3. Sussman, M., *Ann. Rev. Microbiol.*, 1965, **19**, 59.
4. Wright, B. E., *Science*, 1966, **153**, 83.
5. Brown, H. W. and Belding, D. L., In *Basic Clinical Parasitology*, Second Edition, Appleton Century Crofts, New York, 1964, pp. 17, 34.
6. Anon, *WHO Technical Report Series*, 1969, p. 421.
7. McConnachie, E. W. *Parasitol.*, 1969, **59**, 41.
8. Balmuth, W., *J. Parasitol.*, 1962, **48**, 101.
9. Neff, R. J. and Neff, R. H.. *Symp. Soc. Exp. Biol.*, 1969, **23**, 51.
10. Singh, B. N. and Das, S. R., *Phil. Trans. Roy. Soc., B*, 1970, **259 B**, 435.
11. —, Saxena, U. and Iyer, S. S., *Ind. J. expl. Biol.*, 1965, **3**, 110.
12. Raizada, M. K. and Krishna Murti, C. R., *J. Protozool.*, 1971, **18**, 115.
13. Yea Yuan Chi and Francis, D., *J. Cell. Physiol.*, 1971, **77**, 169.
14. Konijn, R. M., Vande-Meeme, J. G. C., Bonner, J. T. and Barkley, D. S , *Proc. Nat. Acad. Sci. U.S.*, 1967, **58**, 452.
15. Konijn, T. M., Barkley, D. S., Chang, Y. Y. and Bonner, J. T., *Ann. Naturalist.*, 1958, **102**, 225.
16. —, Vande-Meeme, J. G. C., Chang, Y. Y., Barkley, D. S. and Bonner, J. T., *J. Bact.*, 1969, **99**, 510.
17. Krichevsky, M. I., Lowe, L. L. and Chassy, B. M., *J. gen. Microbiol.*, 1969, **57**, 383.
18. Barkley, D. S., *Science*, 1969, **165**, 1133.
19. Hall, E. M., Konijn, J. M. Mason, J. W., O'keefe, G. and Wolfe, P. B., *Dev. Biol.*, 1969, **20**, 72.
20. Chassey, B. M., Love, L. L. and Krichevsky, M. I., *Proc. Nat. Acad. Sci. U.S* , 1969, **64**, 296.
21. Bonner, J. T., *Ibid.*, 1970, **65**, 110.
22. Riedel, V. and Gerisch, G., *Biochem. Biophys. Res. Communs.*, 1971, **42**, 119.
23. Murray, A. W., Spiszman, M. and Atkingron, D. E., *Science*, 1971, **171**, 496.
24. Johnson, G. S., Friedman, R, M. and Pastan, I., *Proc. Nat. Acad. Sci. U.S.*, 1971, **68**, 425.
25. Hsie, A. W. and Puck, J. T., *Ibid.*, 1971, **68**, 358.
26. Goldenbaum, P. E. and Dobyogosz, W. J., *Biochem. Biophys. Res Commn* ., 196 , **33**, 828.
27. Perlman, R. L. and Pastan, I., *Ibid.*, 1968. **30**, 656,
28. — and —, *J. biol. Chem.*, 1968, **243**, 5420.
29. Pastan, I. and Perlman, R. L , *Proc. Nat. Acad. Sci. U.S.*, 1968, **61**, 1336.
30. Perlman, R. L., deCrombrugghe, B. and Pastan, I., *Nature*, 1969, **223**, 1810.
31. deCrombrugghe, B., Perlman, R. L., Varmus, H. E. and Pastan, I., *J. Biol. Chem.*, 1969, **244**, 5829.
32. Sutherland, E. W. and Rall, T. W., *Pharmacol. Rev.*, 1960, **12**, 265.
33. Pollard, C. J., *Biochim. biophys. Acta*, 1970, **201**, 511.
34. Azhar, S. and Krishna Murti, C. R., *Bioehem. Biophys Res. Communs.*, 1971, **43**, 58.
35. Raizada, M. K. and Krishna Murti, C. R., Submitted to *J. Cell. Biol.*
36. — and —, Unpublished Work.
37. — and —, Submitted to *Exp. Cell Res.*
38. —, Saxena, K. C. and Krishna Murti, C. R., *J. Protozool*, (In press).
39. Balamuth, W., *J. Infect. Dis.*, 1951, **88**, 230.
40. Chang, S. L., *Parasitol.*, 1946, **37**, 101.
41. Everritt, M., *J. Parasit* , 1950, **36**, 586.
42. Sharma, R. *Trons. Roy. Soc. Lop. Med. Hyg.*, 1959, **53**, 278.
43. Singh, B. N., Srivastava, R. V. N. and Dutta, G. P., *Ind. J. exp. Biol.*, 1971. **9**, 21.

CHEMICAL CONSTITUENTS OF *DAEMIA EXTENSA* (ROOTS)

T. R. SESHADRI AND S. VYDEESWARAN

Department of Chemistry, University of Delhi, Delhi-7

Daemia extensa (Asclepiadaceae) is a well-known Indian herbal drug. It is distributed all over India and has been used in many ways in medicine[1]. Earlier work[2-8] revealed the presence of several triterpenes, sterols and cardenolides. A systematic complete chemical investigation of the plant did not seem to have been carried out eariler. Most of the previous authors have not mentioned clearly the parts that they used. However, Reichstein and co-workers made a thorough study of the cardiac active principles of the aerial parts of the plant. Therefore, as part of a detailed study of vegetable drugs, the roots of the plants which are also used as drug in some parts of India, have now been examined. They were supplied by Bhesheja Bhandar of Calcutta.

Well-crushed, air-dried roots (1 kg) were extracted successively with light petroleum, ether, acetone and alcohol in the cold. The different extracts were studied as described below :

Petroleum ether extract.—By column chromatography over silica gel (column 1) five compounds A, B, C, D and E were isolated as follows : (*i*) Petroleum ether eluates gave compound A in good yield (crystallisation from MeOH–$CHCl_3$ mixture). The fractions from the mother liquor resolved into two compounds A and B on $AgNO_3$ impregnated silica gel plates and could be separated by column chromatography over $AgNO_3$-silica gel. (*ii*) Elution of column 1 with petroleum ether : benzene (1 : 1) afforded a mixture of compounds C and D which again could be separated by preparative TLC ($AgNO_3$ silica gel). Compound E was obtained from the later fractions of the same eluant.

The identities of all the above compounds were established based on specific rotation, mixed m.p., co-chromatography and superimposable IR spectra with authentic samples. Compound A (2·5 g) was identified as lupeol acetate and compound B (700 mg) as α-amyrin acetate. Compounds C (200 mg) and D (150 mg) were identical with lupeol and α-amyrin respectively while compound E (100 mg) agreed with β-sitosterol.

Ether extract.—This was also subjected to column chromatography over silica gel. Compounds A, B, C, D and E were obtained in small amounts from the less polar eluates. 5% MeOH in $CHCl_3$ eluates afforded compound F (120 mg). It answered L-B and Molisch tests and gave, on acid hydrolysis, β-sitosterol and D-glucose. Permethylation[9] followed by hydrolysis yielded 2, 3, 4, 6-tetra-O-methyl-D-glucose, identified by paper chromatography Hydrolysis with almond emulsin also gave β-sitosterol and D-glucose. Hence compound F was β-sitosterol-β-D-glucopyranoside and its identity was confirmed by direct comparison.

Acetone and alcohol extracts.—Colourless cubic crystals (200 mg) separated upon concentration of the alcohol extract and were identified as sucrose by direct comparison and preparation of the acetate.

The remaining alcohol extract and the acetone extract showed similar behaviour on TLC and paper chromatogram and hence were combined. Preliminary purification was effected by repeatedly precipitating the methanol solution with excess of ether. The crude solid, thus obtained, gave positive L-B, Molisch and Legal tests which suggested the possible presence of cardiac glycosides in the mixture.

A portion of the above solid was column chromatographed over silica gel and two Kedde[10,11] positive substances G and H, obtained as a mixture from MeOH : $CHCl_3$ (1 : 9) eluates, were separated by repeated preparative TLC on silica gel G (methylene chloride : methanol : water, 87 : 12 : 1). Compound G (5 mg) was identified as calactin and compound H (4 mg) as calotropin from their properties and confirmed by direct comparison with authentic samples.

The other portion of the crude solid obtained from acetone and alcohol extracts was subjected to Mannich[12] hydrolysis and two aglycones I and J were separated and purified by repeated preparative TLC on silica gel G (ethyl acetate : pyridine : water, 5 : 1 : 4; upper layer). Compound I (8 mg) was identical in all respects with uzarigenin and J with coroglaucigenin. Direct comparison with respective authentic samples confirmed identity. The aqueous portion of the above hydrolysate contained D-glucose and L-arabinose and Kiliani[13] hydrolysis of the crude solid also gave the same two sugars.

These two aglycones are therefore present as glycosides with the above sugars.

In conclusion, the roots of *Daemia extensa* contain the already reported lupeol, α-amyrin, their acetates and β-sitosterol in the light petroleum extract; this seems to be a good source for lupeol acetate. In addition, the ether extract has now been found to contain β-sitosterol-β-D-glucopyranoside. The acetone and alcohol extracts yield calactin and calotropin and glycosides of uzarigenin and coroglaucigenin. In comparison with the aerial parts of the plant, the roots contain cardenolides in less amount and also in less number. Sucrose is also found in the alcohol extract.

ACKNOWLEDGEMENT

The authors thank Professor T. Reichstein, Institute of Organic Chemistry, Basel, Switzerland, Professor H. Mitsuhashi, School of Medicine, Hokkaido, Japan and Dr. R. P. Rastagi, CDRI, Lucknow, for the samples of cardenolides. One of the authors (S.V.) thanks CCRIMH for financial assistance.

---

1. Jain, S. K., *Medicinal Plants*, National Book Trust, New Delhi, India, 1968, p. 106.
2. Gupta, I. J. C., Roy, P. K. and Dutta, A., *Indian J. Med. Res.*, 1946, **34**, 181.
3. Dutta, A. and Ghosh, S., *J. Am. Pharm. Assoc., Sci., Ed.*, 1947, **36**, 250.
4. Pattabi Raman S. and Barua, A. K., *Ibid.*, 1958, **47**, 559.
5. Rakhit, S., Dhar, M. M., Nitya Anand and Dhar, M. L., *J. Sci. Ind. Res., India*, 1959, **18B**, 422.
6. Roy Ghatak, B. J. and De, N. N., *Ibid.*, 1961, **20C**, 51.
7. Mittal, O. P., Tamm Ch. and Reichstein, T., *Helv. Chim. Acta*, 1962, **45**, 907.
8. Mitsuhashi, H., Sasaki, M. and Schimizu, Y., *Chem. Pharm. Bull.*, Japan, 1963, **11**, 1452.
9. Hakomori, S., *J. Biochem.*, 1964, **55**, 205.
10. Kedde, D. L., *Pharm. Tijds, chr. Belg.*, 1947, p. 169.
11. Bush, I. E. and Taylor, D. A. H., *Biochem. J.*, 1952, **52**, 643.
12. Mannich, C. and Siewert, G., *Ber. dtsch. Chem. Ges.*, 1942, **75**, 735.
13. Kiliani, H., *Ibid.*, 1930, **63**, 2836.

CELL CYCLE TIME AND DURATION OF S PHASE IN BARLEY

N. P. SARMA

Nuclear Research Laboratory, Indian Agricultural Research Institute, New Delhi-12

THE effect of chemical and physical mutagens is largely dependent on the physiological state of cell at the time of treatment[1]. Data are now available, which suggest that when cells are treated with chemical mutagens such as ethylmethane sulfonate (EMS) during the period of DNA synthesis (S Phase) of cell cycle the mutation frequency is significantly higher[2-6]. Further the studies of Cerda Olmedo *et al.*[7], have shown conclusively in *E. Coli*, that the maximum frequency of a given type of mutation occurs, when the treatment is given at the time the gene (DNA) is being replicated. Information on cell cycle time and duration of synthetic phase of DNA, therefore, seems to be of considerable significance in chemical mutagenesis programme.

The mitotic cycle time and the initiation of different phases of mitotic cycle were studied in a 6-rowed barley variety NP 104, using selective precursor of DNA, ^3H thymidine. A pulse labelling technique of autoradiography was followed. The roots of 5 mm length were immersed for 30 minutes in aqueous solution of ^3H thymidine of 2·5 c/ml and 6·7 C/m mole specific activity, obtained from New England Nuclear Corporation, Boston, Mass., U.S.A. Samples of root tips were fixed after ^3H thymidine treatment at intervals of 2 hr each, for a total period of 30 hr, approximately covering at least two mitotic cycles. The samples were fixed in a mixture of 3 parts of ethanol and 1 part of glacial acetic acid and stained with feulgen. The terminal 2 mm portion of the root meristem was squashed on gelatinised slides and the cover glasses were removed by dry ice method.

The autoradiographic stripping film (Kodak AR 10) was used for preparation of autoradiographs. The procedure described by Darlington and Lacour[8] has been followed. In order to avoid any delaying effect, the ^3H thymidine fed root tips were not pretreated before fixing. The autoradiographs were scored for ^3H labelled division phases against total mitotic figures, (labelled and non-labelled) to obtain percentage of division phases. These values of labelled mitotic figures were plotted against the period (interval) of fixation time. Mitotic index in untreated root tips was also worked out separately for the various intervals of fixation.

The general procedure developed by Quastler and Sherman[9] and Wimber[10] were employed to provide a basis for the estimation of duration of various phases of mitotic cycle (M.C.). Since ^{3}H thymidine labels a block of cells in interphase, the cycle time therefore can be estimated from the rhythmic appearance and disappearance of these labelled cells in mitosis with time. M.C. time is taken to be the interval of time between two successive ascending portions of such a curve (Fig. 1). The midpoints of two successive peaks of the curve obtained gave an estimate of M.C. time of 12 hr. The average length of S phase was calculated as the distance measured along the 50% intercept between the ascending and descending curves *minus* the labelling time. This gave the value, 5·4 hr and the duration of S phase was approximately 5·4 — 0·5 hr (labelling time) = 4·9 hr.

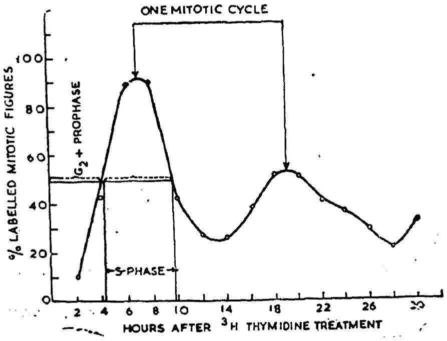


FIG. 1. Frequency of labelled mitotic figures in different intervals of fixation after ^{3}H thymidine treatment.

The average duration of G_2 + prophase was determined as the distance on the abscissa between the origin and vertical line drawn from the point of intersection of 50% intercept with the first ascending curve. The value obtained was 4·0 hr. The mean mitotic index (M.I.) determined from time to time was 8·8 (Fig. 2). This suggests that cell in mitosis spends 1·06 hr in division phases of the total cycle time. Of the total mitotic figures, 58% as obtained from M.I. were in prophase. Hence the prophase time could be about 0·6 hr. The time taken by G_2 alone could also be obtained as G_2 + prophase time — prophase time alone (4·00 — 0·6 hr) = 3·4 hr. G_1, the period between mitosis and the next DNA synthesis was obtained by substracting the sum of individual values of S, G_2 and M from the total time. These values are summarised in Table I.

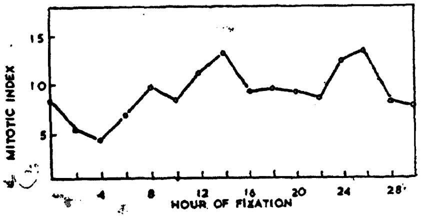


FIG. 2. Mitotic index in the root meristems of barley.

TABLE I

Duration of mitotic cycle and its component phases

Mitotic phase		Estimated average duration (hr)
Synthetic phase (S)	..	4·90
Pre-synthetic gap (G_1)	..	2·64
Post-synthetic gap (G_2)	..	3·40
Mitosis (M) (Prophase to Telophase)		1·06
Mitotic cycle (M.C.)	..	12·00

The mitotic cycle time in the barley root meristem determined in the present study seems to be short (12 hr) as compared with those reported for *Vicia faba* (30 hr by Howard and Pelc[11]) *Tradescantia paludosa* (20 hr by Wimber[10]), *Pisum sativum* (18 hr by Van't hof[12]). However, it corresponds more closely with the M.C. time of *Crepis capillaris* (10·75 hr) and *Lycopersicon esculentum* (10·6 hr) as studied by Van't hof[12]. The duration of S phase is approximately a little longer than one-third of the total time. Van't hof[12] worked out the relationship between S phase and M.C. time in several plant species and observed it to be the sum of S period and a constant of 5·25–6·5 hr. This relationship seems to hold good for the current estimate of cell cycle time.

I am indebted to Dr. M. S. Swaminathan for his guidance.

---

1. Grant, C. J., Heslot, H. and Ferrary, R. *Chromosomes Today*, (ed. Darlington, C. D. and Lewis, K. R., Oliver and Boyd., Edin.), 1969, **2**, 75.
2. Natarajan, A. T. and Shivashankar, G., *Z. Vererbungsl.*, 1965, **96**, 13.
3. Savin, V. N., Swaminathan, M. S. and Sharma, B, *Mutation Res.*, 1968, **6**, 101.
4. Mikaelsen, K., Ahnstrem, A. and Li, W. C., *Hereditas*, 1968, **59**, 353.
5. Shevchenko, V. A., Pyatyshev, D. P. and Dolzhikova, L. P., *Genetika*, 1969, **5** (3), 61.
6. Cechacek, Z. and Hillova, J., *Int. J. Radiat. Biol.*, 1970, **17**, 127.
7. Cerda'Olmedo, E., Hanawalt, P. C. and Guerola, N., *J. Mol. Biol.*, 1968, **33**, 705.
8. Darlington, C. D. and Lacour, L. F., *Handling of Chromosomes*, Allen and Unwin, London, 1960.
9. Quastler, H. and Sherman, F. C., *Exptl. Cell Res.*, 1959, **17**, 420.
10. Wimber, D. E., *Amer. J. Bot.*, 1960, **47**, 824.
11. Howard, A. and Pelc, S. R., *Heredity*, 1953, **6**, (Suppl.), 261.
12. Van't hof, J., *Exptl. Cell Res.*, 1965, **39**, 48.

LETTERS TO THE EDITOR

ON THE FORMATION OF CO_2^- IN THE MICROWAVE DISCHARGE OF CO_2

It has been established by a number of spectroscopic investigations[1,2] as well as the radio-occultation measurements from Mariner IV[3] and V[4] that carbon dioxide is the predominant constituent of the martian and venutian atmospheres. Laboratory investigation of CO_2 spectra excited by different methods has, therefore, assumed great importance. The spectra of CO_2 has been excited by radio-frequency discharge[5], electron impact[6] and proton bombardment[7]. Evans and Jennings[8] analysed the products of radio-frequency discharge mass-spectrometrically. Recently, Gupta[9] has studied the microwave discharge of CO_2 in the laboratory and found the discharge to contain mainly the bands of CO, CO_2 and CO_2^+. The photometric study of the Angstrom band of CO at 4393 Å revealed that its intensity decreases linearly with the partial pressure of CO_2 in the range 40–240 mtorr (Fig. 1). He proposed the following mechanism for the excitation of this band :

$$CO_2^{+*} + e \xrightarrow{k_1} CO^* + O \quad (1)$$

$$CO^* \xrightarrow{A} CO + h\nu, \quad (2)$$

where $h\nu$ stands for the Angstrom bands and A, probability of the transition $B\,{}^1\Sigma^+ - A\,{}^1\Pi$. No explanation was put forward to account for the linear decrease of the intensity.

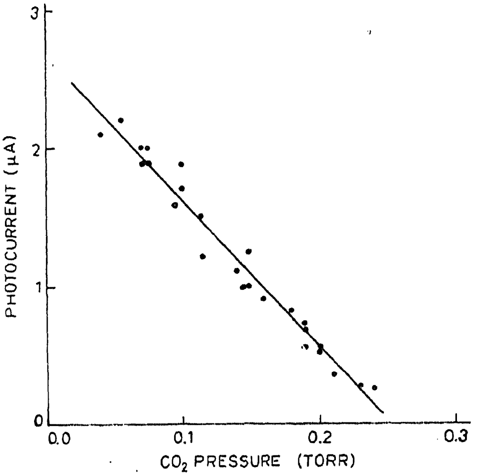


FIG. 1. Variation of the intensity of (1, 1) Angstrom Band at 4393 Å with carbon dioxide pressure.

The following reactions may be responsible for the observed decrease in the intensity of 4393 Å band :

$$CO^* + CO_2 \xrightarrow{k_3} CO' + CO_2' \quad (3)$$

$$CO_2 + e \xrightarrow{k_4} CO_2^-. \quad (4)$$

Considering reactions (1)-(4), one finds that the intensity, I, of the 4393 Å Angstrom band is given by

$$I = \frac{I_0 - k_4\,[e]\,[CO_2]}{1 + k_3/A\,[CO_2]}, \quad (5)$$

where I_0 is the unquenched intensity of the band under consideration. I_0 may be assumed to be constant (Shukla *et al.*[10]) and $[e]$ is a fixed quantity as the CO_2 discharge is maintained at a constant microwave power. Since the observed intensity of 4393 Å band decreases linearly with $[CO_2]$ (Fig. 1), the role of the second term in the denominator of equation (5) appears to be negligible. Hence, this analysis leads to an important conclusion that CO_2^- are formed in the microwave discharge of CO_2.

Recently, Whitten *et al.*[11] have considered the ion chemistry of the martian atmosphere and proposed the existence of negative ion species CO_3^-, CO_4^- and CO^-.

In view of above observations, the presence of CO_2^- ions in the upper atmospheres of Mars and Venus may be expected. This may significantly affect the ion chemistry of the ionospheres of these planets.

J.K. Institute of
Applied Physics
and Technology,
University of Allahabad,
Allahabad, India, *August* 16, 1971.

R. V. Shukla.
S. K. Gupta.
A. N. Srivastava.

---

1. Kaplan, L. D., Munch, G. and Spinard, H., *Astro Phys. J.*, 1964, **139**, 1.
2. Chase, S. C., Kaplan, L. D. and Nengebaner, G., *J. Geophys. Res.*, 1963, **68**, 6157.
3. Kliore, A., Cain, D. L, Levy, G. S., Eshlewan-V. R., Fjeldbo, G. and Drake, F. D., *Science*, 1965, **148**, 1243.
4. —, Levy, G. S., Cain, D. L., Fjeldo, G. and Rasool, S. I., *Ibid.*, 1967, **158**, 1683.
5. Higashino, 1. and Hitomi, M., *Mem. Fac. Engg.*, Osaka City Univ. (Japan), 1963, **5**, **99**.

6. Kishko, S. M. and Skubenich, V. V., *Bull. Acad. Sci., U.S.S.R., Phy. Ser.* (*U.S.A.*), 1964, **27**, 1023.
7. Ponlizac, M. C. and Dufay, M., *Astrophys. Letters*, 1967, **1**, 17.
8. Evans, H. E. and Jennings, P. P., *Trans. Faraday Soc.*, 1965, **61**, 2153.
9. Gupta, S. K., *Ph. D. Thesis*, Univ. Allahabad, 1970.
10. Shukla, R, V., Jain, S. K., Gupta, S. K. and Srivastava, A. N., *J. Chem. Phys.*, 1970, **52**, 2744.
11. Whitten, R. C., Poppoff, I. G. and Sims, J. S., *Planet. Space Sci.*, 1971, **19**, 243.

PHOTODECOMPOSITION OF AZIDOPENTAMMINE AND DIAZIDOTETRAMMINE COBALT (III) COMPLEXES

IRRADIATION of azidopentamminecobalt (III) complex solutions at $\lambda = 370$ mμ yielded Co (II) and molecular nitrogen[1]. Flash photolysis[5] of this complex revealed the presence of the transient azide radical. Solutions of diazidotetramminecobalt (III) complexes undergo photolysis much faster and are less stable in the dark than solutions of azidopentamminecobalt (III) complexes. On irradiation at $\lambda = 360$–450 mμ, solutions of the azido complexes attained the pale rose colour due to the formation of cobaltous ion with the evolution of nitrogen. In the presence of vinyl monomers like acrylamide, methacrylamide, acrylic acid, methylacrylate, methylmethacrylate, acrylonitrile, etc.[2,3], under deaerated conditions, polymerization took place with no visible evolution of nitrogen.

The rate of decomposition of the complexes in acid medium was found (spectrophotometrically) to vary linearly with the light absorption fraction (Fig. 1 A) and light intensity. The quantum yields for the decomposition of monoazido complex and diazido complex were found to be 0·192 and 0·236 respectively. These values were very similar to those obtained in the presence of vinyl monomers[2,3], *viz.*, 0·19 for the monoazido complex and 0·27 for the diazido complex. This has led us to believe that the primary photochemical act of the photoexcitation of the complex, the dark back reaction leading to the deactivation of the complex and the redox decomposition of the excited complexes yielding the azide radicals are independent of the presence of monomer. In the absence of polymerization the azide radicals interacted mutually evolving molecular nitrogen: $2\,N_3 \rightarrow 3\,N_2$. As a result of the detailed kinetic investigation of the decomposition of diazidotetramminecobalt (III) complex,

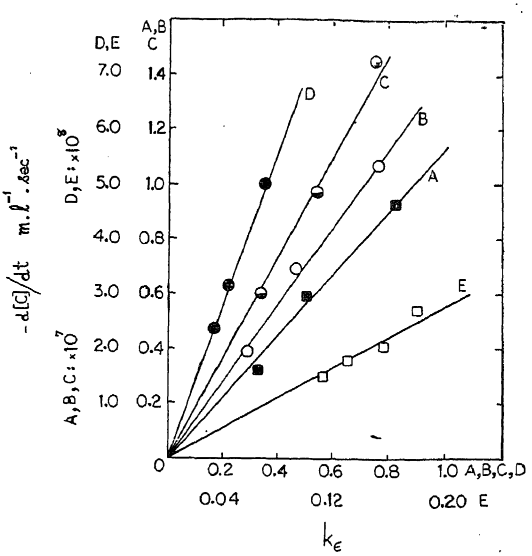


PHOTO-DECOMPOSITION OF COBALT-AZIDE COMPLEXES

A,B,C: AZIDOPENTAMMINE

D,E: DIAZIDO TETRAMMINE

FIG. 1 A. A, B, C, — azidopentamminecobalt (III) chloride. $\lambda = 365$ mμ; 1×10^7 Nhv. l. sec.; A—5·896, B—6·869, C—9·835. D, E,—Diazidotetramminecobalt (III) azide; D—$\lambda = 365$ mμ; $I = 5{\cdot}91 \times 10^{-8}$ Nhv l^{-1} sec.$^{-1}$. E—$\lambda = 405$ mμ, $I = 5{\cdot}866 \times 10^{-8}$ Nhv l^{-1} sec.$^{-1}$.

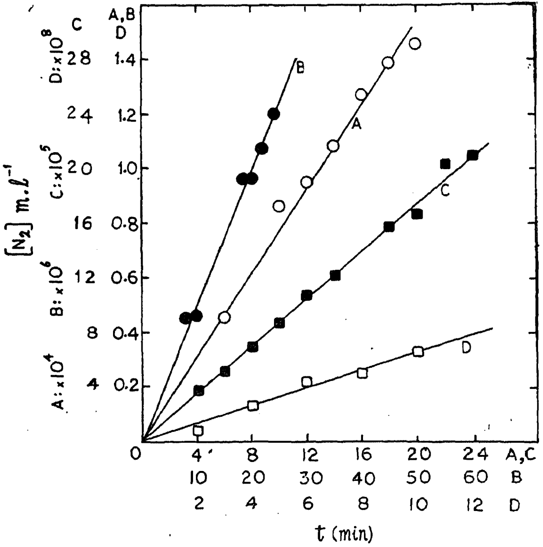


PHOTO-DECOMPOSITION OF AZIDOPENTAMMINE COBALT (III) CHLORIDE EVOLVING NITROGEN

FIG. 1 B. Azidopentamminecobalt (III) chloride. $\lambda = 635$ mμ; $I = 1{\cdot}403 \times 10^{-6}$ Nhv. l. sec. k_ϵ : A—0·4479; B—0·5247; C—1; D—0·3840.

both in the presence and in the absence of monomer, the quantum yields for the complex disappearance are reported for the first time.

Supplementary to the spectrophotometric studies, gasometric studies of the nitrogen evolution were also made. Solutions of the monoazido complex were irradiated at $\lambda = 365\ m\mu$ and the amount of nitrogen evolved was measured (in a dilatometer devised by us) and plotted against time (Fig. 1 B). The average quantum yield obtained was $\sim 0{\cdot}135$. The evolution of nitrogen ceased completely only after three days.

The low quantum yields for photoredox decomposition and the small change of the quantum yield with the increase of wavelength of the irradiating light may be understood in terms of (*a*) the excitation of the complex in the primary photochemical act and (*b*) the postulate that electronically excited states of moderately long lifetime (which can undergo internal conversion before reactive deactivation) are intermediates in photochemical reactions of cobalt (III)[4]. Inefficiencies observed in the photoaquation and photoreduction of cobalt (III) complexes are the result of competing reactions of the electronically excited states of the complexes.

Dept. of Physical Chemistry, H. KOTHANDARAMAN.
M. SANTAPPA.
University of Madras,
Madras-25, *July* 23, 1971.

---

1. Linhard, M. and Weigel., M., *Z. anorg. allgem. Chem.*, 1951, **49**, 266.
2. Natarajan, L. V. and Santappa, M., *Polymer Letters*, 1967, **5**, 357.
   — and —, *J. Polymer Sci.*, 1968, A-1, **6**, 3245.
   — and —, *Proc. Ind. Acad. Sci.*, 1969, **69 A** (4), 284.
3. Kothandaraman, H. and Santappa, M., *Curr. Sci.*, 1970, **39**, 532.
   — and —, *Polymer Journal* (Japan), 1971, **2**, **148.**
   — and —, *J. Polymer Sci.*, A-1 (In press).
4. Valentine, D., *Advances in Photochemistry*, Interscince, N.Y., 1963, **6**, 123.
5. Adamson, A. W. and Penkett, S. A., *J. Am. Chem. Soc.*, 1965, **87**, 2514.

COMMENTS ON THE PAPER "A NEW APPROACH TO THE ELOVICH EQUATION" BY VISWANATH *ET AL.*[1]

R. P. VISWANATH *et al.*[1] have recently analysed the kinetics of chemisorption of hydrogen on iron oxide. Over a wide range of temperature and pressure the chemisorption followed the Elovich equation[2,3],

$$q = \frac{1}{\alpha}\, ln\,(t + t_0) - \frac{1}{\alpha}\, ln\, t_0$$

where $q =$ amount chemisorbed at time t, and α and t_0 are constants. If $q = 0$ at $t = 0$ then $t_0 = 1/\alpha\, a$ where a is the rate of chemisorption at $t = 0$.

I have recently emphasised[4] that the role of t_0 is purely mathematical and that no physical significance can be attached to the value of t_0. Viswanath *et al.*[1] questioned this statement in the case of their measured chemisorption on iron oxide because plots of q against log $(t + t_0)$ intersected the log $(t + t_0)$ axis at log (t_0). They concluded that this indicated an induction period for the chemisorption and that t_0 was the length of this induction period which preceded the chemisorptions.

It should be pointed out that the intersection of integrated Elovich plots at log (t_0) on the log $(t + t_0)$ axis is precisely what *must* occur if Elovich kinetics apply with $q = 0$ at $t = 0$. The data of Viswanath *et al.* cannot therefore be taken as evidence of a mechanistic significance for t_0 but do indicate that this chemisorption is accurately described by the Elovich equation for the entire course of the reaction. The data are thus of particular interest since it has been shown[5] that the majority of chemisorptions obey Elovich kinetics only after an initial process which follows different kinetics.

Isotopes Laboratory, I. S. McLINTOCK.
University of Dundee,
Dundee, Scotland, *October* 16, 1971.

---

1. Viswanath, R. P., Viswanathan, B., Srinivasan, V. and Sastri, M. V. C., *Curr. Sci.*, 1970, **39** (18), 407.
2. Roginsky, S. Z. and Zheldovich, J,. *Acta Physicochim. U.S.S.R.*, 1934, **1**, 554.
3. Low. M. J. D., *Chem. Rev.*, 1960, **60, 267.**
4. McLintock, I. S., *J. Catalysis*, 1970, **16**, 126.
5. —, *Nature*, 1967, **216**, 1204.

γ-PICOLINE COMPLEX OF COPPER (II) IODIDE

DIVALENT copper ion having a non-spherical $3\,d^9$ non-bonding shell is subjected to Jahn-Teller distortions and hence exhibits square planar configuration as a limit to axial octahedral distortion. Several complexes of copper (II) have been reported[1-3] earlier by us. In this communication, a copper (II) iodide complex with γ-picoline having the composition $[Cu\ (\gamma\text{-pic})_3I_2 . H_2O]$ is described.

To an aqueous solution of $CuSO_4 . 5H_2O$, excess γ-picoline was added and the mixture shaken till a deep blue solution was obtained. The solution was warmed and potassium iodide was added gradually in small quantities with thorough shaking till a blue precipitate appeared. The precipitate was filtered, washed thoroughly with methanol till the blue tint was removed leaving behind a green amorphous complex. It was washed with ether and dried *in vacuo*. The purity of the isolated compound was established by estimating metal and halogen by standard methods. (Found: Cu, 10·13%; I, 41·05% [Cu $(\gamma\text{-pic})_3I_2 . H_2O$] requires Cu, 10·34%; I, 41·38%.) Conductance measurement was carried out in 0·001 M acetone solution using a Toshniwal Conductivity Bridge and magnetic susceptibility was determined on solid specimens using Gouy method. I.R. spectra were recorded on Nujol mulls using a Unicam SP-200 spectrophotometer. Chloroform solution (0·01 M) of the compound was used to record the electronic spectra in the visible range. I.R. and electronic spectral data are given below:

* *I. R. spectra* (cm^{-1})	*Electronic spectra*
728s, 825vs, 970w, 1040s. 1075s, 1235s, 1520m, 1630s, 3500br (742s, 823s, 1015vs, 1060m, 1235s, 1430w, 1460w, 1610vs)	$\gamma_{max.}$ (cm^{-1}) (ϵ) 14,800 (31)

*The free ligand (γ-picoline) absorption bands are given in parenthesis.

Cupric iodide is unstable and gets converted to cuprous iodide and iodine. Complexes of copper (II) iodide are known with chelating ligands[4-6]. The nature of the compounds $CuI_2 . nNH_3$ [$n = 2$, or 6] is not well known[7]. Goodgame and co-workers[8] reported [Cu $(\text{imidazole})_4I_2$] and its structure has been determined by X-ray diffraction. Bose *et al.*[9] have described a similar complex with benzimidazole having the composition [Cu $(\text{bzd})_4I_2$].

The green amorphous complex having the composition [$Cu(\gamma\text{-pic})_3I_2.H_2O$] reported in the present investigation is soluble in acetone, in which medium it is a nonelectrolyte, Λ_m being 16·4 mhos. It is paramagnetic in the solid form, indicating the presence of one unpaired electron (= 1·84 B.M.) and hence the copper atom is in the divalent state. Infra-red spectra show the presence of a broad band at 3500 cm^{-1} indicating the presence of co-ordinated water molecule. Some ligand absorption bands are shifted indicating the bonding of the ligand (γ-picoline) to the metal. Absorption spectrum of a chloroform solution in the visible range showed a broad absorption band at 14800 cm^{-1} region. Hence a tetragonally distorted octahedral configuration with weakly bonded iodide ions along the tetragonal axis, as in the corresponding imidazole[8] and benzimidazole[9] complexes, is suggested for the present compound. This is yet another example of a cupric ion stabilised in presence of an iodide ion by complexing.

Dept. of Chemistry, B. K. Mohapatra.
Regional Engineering D. V. Ramana Rao.
College,
Rourkela 8, August 2, 1971.

---

1. Mohapatra, B. K. aud Ramana Rao, D. V., *Indian J. Chem.*, 1970, **8**, 564.
2. — and —, *Ibid.*, 1971 (in press).
3. — and —, *Ibid.*, 1971 (in press).
4. Barclay, G. A., Hoskins, B. F. and Kennard, C. H. L., *J. Chem. Soc.*, 1963, P. 5961.
5. Proctor, I. M., Hathaway, B. J. and Nicholls, P., *Ibid.*, 1968, p. 1678.
6. Harris, C. M., Lockyer, T. N. and Waterman, H., *Nature*, 1961, **192**, 424.
7. Ephraim, F., *Chem. Ber.*, 1919, **52**, 940.
8. Akhtar, F., Goodgame, D. M. L., Raynes-Canhan, G. W. and Skaspiki, A. C., *Chem. Commun.*, 1968, p. 1389.
9. Bose, K. S., Sarma, B. C. and Patel, C, C., *J. Inorg. Nucl. Chem.*, 1969, **32**, 1742.

COMPLEXES OF 5, 5′-THIODISALICYLIC ACID WITH SOME d^{10}-TRANSITION METAL IONS

This communication describes the isolation and characterisation of complexes of Ag (I), Hg (II), Th (IV) and UO_2 (VI) with 5, 5′-thiodisalicylic acid, an industrially[1-4] important compound. Mode of co-ordination of the ligand has been deduced from the infrared spectroscopic data. Earlier references cited in the literature on complexation reactions of 5, 5′-thiodisalicylic acid (abbreviated hereafter as TDSA) with some transition metal ions relate to the studies in solution[5,6].

For preparing the complexes, an alcoholic solution of TDSA (0·1 M, 100 ml) was added in each case to aqueous solution of the metal ion (0·1 M, 25 ml) concerned and the mixture was refluxed for about an hour. The precipitated complex was filtered, washed with water, alcohol and acetone and dried in an electric-oven at 80° C. The analysis gave the formulae, shown in Table I, for the compounds thus obtained.

The complexes did not dissolve either in water or in common organic solvents suggesting their polymeric nature. No cryoscopic or conductometric measurements could, therefore, be made.

Magnetic measurements on solid complexes were made by Guoys' method using mercury

TABLE I

Complexes	Colour	M.P.* (°C)	% M		% S		% C		% H	
			Calcd.	Found	Calcd.	Found	Calcd.	Found	Calcd.	Found
$H[Ag(C_{14}H_8O_6S)].2H_2O$ ..	White	190	24·05	23·80	7·12	7·28	37·41	37·50	2·89	2·40
$[Hg(C_{14}H_8O_6S)(H_2O)_2]$ ..	,,	285	37·10	36·40	5·94	5·82	..	..	..	..
$[Th(C_{14}H_8O_6S)_2(H_2O)_4]$ ..	Yellow	280	25·43	24·81	7·01	6·82	36·84	37·10	2·63	2·10
$[UO_2(C_{14}H_8O_6S)(H_2O)_2].3H_2O$	Orange	300	35·84	35·90	4·82	5·01	25·30	25·31	2·71	2·80

* Complexes decomposed on heating above the temperature mentioned.

(II) tetrathiocyanatocobaltate (II) ($X_g = 16 \cdot 44 \times 10^{-6}$ c.g.s. units) as calibrating agent. Silver, mercury and uranyl complexes showed a diamagnetic nature (susceptibilities being $-1 \cdot 21 \times 10^{-6}$, $-5 \cdot 60 \times 10^{-6}$ and $-1 \cdot 64 \times 10^{-6}$ respectively in c.g.s. units) as expected for the filled d^{10} electron-configuration. The thorium complex was found to be slightly paramagnetic ($X_{M corr} = 286 \cdot 7 \times 10^{-6}$ c.g.s. units). For several reasons[7], the interpretation of magnetic data in actinides is rather difficult. However, the observed paramagnetism does not seem to have much significance.

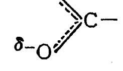
The infrared spectra of the ligand and the complexes under investigation were recorded from their KBr-pellets on a 'Perkin Elmer-521' spectrophotometer in the range 4000 cm^{-1} — 250 cm^{-1}. The absorption bands of diagnostic value and their tentative assignments are given in Table II. Infrared spectral data indicate co-ordination through the carboxylic group only.

TABLE II

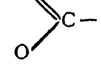
Silver-complex (cm^{-1})	Mercury-complex (cm^{-1})	Thorium-complex (cm^{-1})	Uranyl-complex (cm^{-1})	TDSA (cm^{-1})	Asignments
1540	1560	1500	1550	1660	$^{\nu}\mathrm{C}\overset{O}{\underset{O}{<}}$ (asym.)
1600	1600	1610	1600	1600	$^{\nu}\mathrm{C}\overset{O}{\underset{O}{<}}$ (sym.)
1150	1165	1150	1150	1200	$^{\delta}\mathrm{C}\overset{O}{\underset{O}{<}} + {}^{\nu}\mathrm{C—O}$
*	*	435	400	..	$^{\nu}\mathrm{M—O}$

* The range could not be covered in these cases.

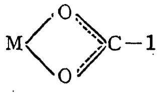
Out of the following possible modes[8] of co-ordination for carboxylic group,



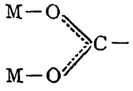
(I)



(II)



(III)



(IV)

the data obviously favours structure (II) for the complexes under study.

Thanks are due to The Atomic Energy Commission, Government of India, for awarding a Senior Research Fellowship to one of the authors (K. B. P.).

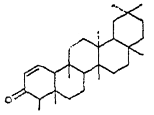
Chemical Laboratories,
University of
Allahabad,
Allahabad, *July* 12, 1971.

H. L. NIGAM.
K. B. PANDEYA.
P. C. SRIVASTAVA.

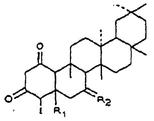
1. Edward, E. D. and Elliott, J. S., *U.S.* 2, 1958 (Jan. 21) 820, 766.
2. Elliot, A. E. and Elliot, J. S., *Ibid*, 1946 (Mar. 19), 396, 839.
3. —, *Ibid.*, 1954 (Oct. 26), 692, 862.
4. Kulkarni, D. M. aud Airan, J. W., *J. Ind. Chem. Soc.*, 1951, 28, (10), 595.
5. Srivastava, S. C. and Good, L. M., *Talanta*, 1965, **12**, 181.
6. Kumar, A. N., Srivastava, P. C. and Nigam, H. L., *Indian J. Chem.*, 1971, **9** (5), 488.
7. Figgis, B. N., *Introduction to Ligand Fields*, Interscience Publishers, New York, 1966, p. 327.
8. Amirthalingam, V. and Padmanabhan, V. M., *Acta Cryst.*, 1958, **11**, 896.

STRUCTURE OF SOME CRYSTALLINE COMPONENTS OF *SALACIA PRENOIDES*

IN continuation of our earlier[1] brief note on some terpenoid components from *Salacia prenoides* D.C., we report now on the structures of three more components from the same source. One of these has been proved to be friedel-1-ene-3-one (I) by means of a two-way correlation with friedelin (friedelane-3-one) (II). Another has been proved to friedelane-1, 3-dione-7α-ol (III) by transforming it into friedelane-3, 7-dione (IV) which is already known as a natural product under the name putranjivadione[2]. The third compound has been shown to be friedelane-1, 3-dione-24-al (V) by its transformation into friedelane-3-one-24-ol (VI) and friedelane-3-one-24-al (VII).

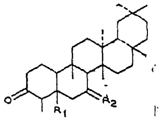


(I)



(III) $R_1 = CH_3$; $R_2 = \langle^{OH}_{H}$

(V) $R_1 = CHO$; $R_2 = H_2$



(II) $R_1 = CH_3$; $R_2 = H_2$

(IV) $R_1 = CH_3$; $R_2 = O$

(VI) $R_1 = CH_2OH$; $R_2 = H_2$

(VII) $R_1 = CHO$; $R_2 = H_2$

The authors thank the Central Council for Research in Indian Medicine and Homoeopathy for financial assistance, Dr. M. L. Dhar, Director and Dr. Nitya Anand, Scientist, Central Drug Research Institute, Lucknow, for NMR and mass spectra and Prof. T. R. Seshadri, F.R.S., for his kind interest.

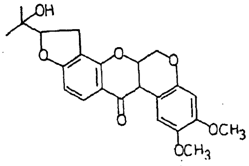
Chemistry Dept., N. C. Tewari.
Delhi University, K. N. N. Ayengar.
Delhi-7, *August* 10, 1971. S. Rangaswami.

---

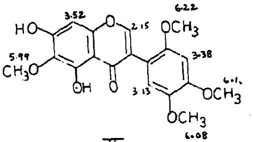
1. Rangaswami, S. and Tewari, N. C., *Curr. Sci.*, **1971**, **40**, 36.
2. Sengupta, P., Chakraborty, A. K., Duffield, A. M., Durham, L. J. and Carl Djerassi, *Tetrahedron.*, 1968, **24**, 1205.

THE OCCURRENCE OF CAVIUNIN IN *DALBERGIA PANICULATA* (N. O. LEGUMINOSAE)

Besides the isolation of dalpanol[1] (I) from the benzene extraction of the defatted ripe seeds of *D. paniculata*, we have also isolated from the mother liquors of the same extract a known isoflavone[2], caviunin (II) as a minor constituent by 2% aqueous sodium carbonate fractionation, followed by repeated column chromatography over deactivated neutral alumina. By adopting the same isolation procedure we have also found the presence of caviunin in the root, wood and flowers of *D. paniculata*. The percentage of caviunin content varies between 0·005 to 0·01. In the case of flowers, however, caviunin is not in isolable amount and its presence is shown only by chromatography [Paper (descending) BuOH : AcOH : H_2O, 4 : 1 : 5 v/v, R_f 0·91; t.l.c. silicagel G, Benzene : Dioxan : AcOH, 90 : 25 : 4 v/v, R_f 0·69; t.l.c. polyamide, EtOH : H_2O, 3 : 2 v/v, R_f 0·55]. The elemental analysis and mass spectrum leads to the molecular formula $C_{19}H_{18}O_8$ and the fragmentation pattern agreed with that recorded earlier[3]. Identity of the compound with an authentic sample of caviunin (kindly provided by Prof. O. R. Gottlieb) is established by, m.p., m.m.p., co-chromatography, U.V. and I.R. spectra. Although the structure of caviunin has been confirmed by synthesis[4], its NMR spectrum has not been studied. Its spectrum taken in $CDCl_3$ on a 60 McVarian instrument shows all the signals as singlets. The assignment of the chemical shifts (τ) is shown in (II). The higher value of 6·22 for 2′-methoxy is noteworthy, which is in agreement with the reported range 6·23–6·29[5]. This occurrence of caviunin along with dalpanol in a *Dalbergia* species illustrates the co-occurrence of a rotenoid and 2′-methoxy isoflavonoid, a feature of biogenetic significance met with in certain other genera[6-9] belonging to *Fabaceae*.



I



II

Including the present report, the presence of caviunin has been shown only in three plants[2,10] belonging to the genus *Dalbergia*. Consideration of this fact together with the presence of caviunin in almost all the parts of *D. paniculata* leads to its possible recognition as a 'taxonomic marker'.

We thank Prof. T. R. Seshadri, F.R.S. for NMR spectrum, Prof. O. R. Gottlieb for a sample of caviunin and the University Grants Commission for the award of Research Scholarship (J.R.R. and M.R.).

Dept. of Chemistry. D. Adinarayana.
S.V. University, M. Radhakrishniah.
Tirupati (A.P.) J. Rajasekhara Rao.
August 7, 1971.

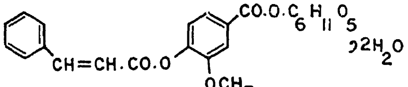
---

1. Adinarayana, D., Radhakrishniah, M., Rajasekhara Rao, J., Campbell, R. and Crombie, L., *J. Chem. Soc.* (C), 1971, p. 29.
2. Gottlieb, O. R. and Magalhaes, M. T., *J. Org. Chem.*, **1961**, **26**, 2449.
3. Reed, R. I. and Wilson, J. M., *J. Chem. Soc.*, 1963, p. 5949.
4. Dyke, S. F., Ollis, W. D. and Sainsbury, M., *J. Org. Chem.*, 1961, **26**, 2453.
5. Campbell R. V. M. Harper, S. H. and Kemp, A. D., *J. Chem. Soc.* (C), 1969, p. 1787.
6. Crombie, L. and Whiting, D. A., *Ibid.*, 1963, p. 1569.
7. Falshaw, C. P., Ollis, W. D., Moore, J. A. and Magnus, K., *Tetrahedron*, 1966, Supplement **7**, p. 333.
8. Ollis, W. D., Rhodes, C. A. and Sutherland, I. O., *Ibid.*, 1967, **23**, 4741.
9. Krishnamurti, M., Sambhy, Y. R. and Seshadri, T. R., *Ibid.*, 1970, **26**, 3023.
10. Ollis, W. D., *Experientia*, **1966**, **22**, 777.

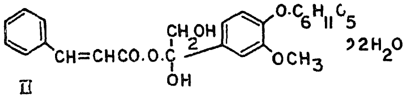
CHEMISTRY AND PHARMACOLOGY OF APOCYNIN, ISOLATED FROM *PICRORHIZA KURROA* ROYLE EX BENTH.

Picrorhiza kurroa Royle ex Benth. (Scrophulariaceae) (Hindi—*Kutki* or *Katki*)[1] is a wild plant which grows from Kashmir to Sikkim at an altitude of 9,000 to 15,000 ft. The roots and rhizomes are extremely bitter to taste and have been recommended as a substitute for the imported gentian roots. They are extensively used in the indigenous system of medicine as an antiperiodic, stomachic, cathartic, and cholagogue. In a detailed pharmacological investigation Das and Raina[2] observed that the water-soluble fraction of the alcoholic extract of the roots of *P. kurroa* possessed relaxant and non-specific antispasmodic effect on isolated ileum of rabbit, albino rat, rat uterus and intestine *in situ* of dog. Intravenous administration showed a prolonged choleretic effect in dogs and oral administration had laxative effect in albino rats. Daily oral administration in rats for one month protected the animals to a great extent against the carbon tetrachloride induced hepatic damage. These pharmacological observations along with the successful use[3] of the drug in clinical cases of infective and amoebic hepatitis indicated that the active principle of the drug is possibly kutkin, a bitter glucoside, $C_{23}H_{24}O_{10}\cdot 2H_2O$, m.p. 211°, $[\alpha]_D^{41} - 165°$, which was isolated and assigned structure (I) by Rastogi *et al.*[4]. In a recent communication[5] we have shown that structure (I) proposed for kutkin is not consistent with the biogenetic principles applicable to lignins, known to be derived from C_6–C_3 units and D-glucose precursors, and proposed a revised structure (II) for kutkin on the basis of chemical and physical evidences (i.r., n.m.r. and mass spectra). The free occurrence of vanillic acid in the roots of *P. kurroa*[4] prompted us to search for other lignin building stones, if any, present in the roots. We report here the isolation of 4-oxy-3-methoxy-acetophenone (III) from the roots of *P. kurroa* together with the pharmacology of the compound. This would further substantiate our contention for the new structure (II) proposed by us for kutkin on the basis of biogenetic considerations. The ketone (III) was first isolated under the name of *Apocynin* from *Apocynum canabinum*[6].

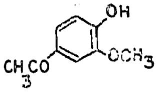
(*a*) *Chemical.*—The petroleum ether extract of dried milled roots of *P. kurroa* on fractional crystallisation afforded a crystalline ketone, $C_9H_{10}O_3$, m.p. 114–115° (needles from benzene, yield 0·033%); R_f 0·23 (SiO_2 G TLC; C_6H_6 : $CHCl_3$, 1 : 3; I_2 vapour); green colour with alcoholic $FeCl_3$, violet colour with aq. $FeCl_3$; positive Zimmerman reaction for $-CO.CH_2-$ group with *m*-dinitrobenzene and alkali; i.r. ν_{max} 3300 (OH), 1680 (CO) cm^{-1}; n.m.r. significant signals at δ 2·6 ($CH_3.CO.Ar$), 3·95 ($CH_3O.Ar$), 6·52 (HO.Ar), 6·92, 7·08, 7·35 (H.Ar) (Found: C, 65·2, 65·4; H, 6·13, 6·20. Calcd. for $C_9H_{10}O_3$: C, 65·05; H, 6·07). Mass spectrum showed the molecular ion peak at m/e 166 (M^+, 50%), and then significant fragment-ions at m/e 151 ($M-CH_3$, 100%), 136 ($M-2CH_3$, 5%), 123 ($M-COCH_3$, 18%), 108 ($M-COCH_3-CH_3$, 13%), 93 ($M-COCH_3-OCH_3+H$, 3%), 77 ($M-COCH_3-OCH_3-OH+2H$, 8%), 43 ($CH_3.C\equiv\overset{+}{O}$, 8%). The ketone formed a light yellow crystalline phenyl hydrazone, m.p. 125–126° (Found: C, 70·14, 70·28; H, 6·52, 7·02. Calcd. for $C_9H_{10}O_2=N.NH.C_6H_5$: C, 70·29; H, 6·29), and a colourless crystalline semicarbazone, m.p. 170–171° (alcohol-ether) (Found: C, 52·90, 53·40; H, 6·11, 6·47. Calcd. for $C_9H_{10}O_2=N.NH.CONH_2$: C, 53·80; H, 5·87).



I



II



III

The ketone was identified as 4-oxy-3-methoxy-acetophenone (III) from a comparison of the above chemical and spectroscopic data with those of related isomeric compounds reported in literature, *viz.*, (*i*) 4-oxy-3-methoxy-acetophenone, apocynin, acetovanillone, m.p. 115°[6], 115–116°[7]; phenyl hydrazone, m.p. 125°[7]; semicarbazone, m.p. 167°[6], 172–173°[8]; (*ii*) 2-oxy-4-methoxy-acetophenone, paenol, m.p. 51°[9]; phenyl hydrazone, m.p. 108°[10]; (*iii*) 3-oxy-4-methoxy-acetophenone, isoacetovanillone, m.p. 66–69°[7], blue-violet colour with $FeCl_3$.

(*b*) *Pharmacological*.—An aqueous solution of apocynin, 4-oxy-3-methoxy-acetophenone, was used for pharmacological investigations, and the findings are as follows :—

1. *Smooth muscles*.—The effect of the drug was seen on isolated ileum of guineapig and rabbit, and isolated uterus of albino rat (quiescent and contracting). The drug produced a moderate to marked relaxation of rabbit ileum and contracting rat uterus in concentrations of 50–200 mcg/ml. It antagonised spasms induced by various spasmogens on guineapig ileum and rat uterus. The spasmolytic ED_{50} was calculated in each case by log dose-percentage inhibition curves and are given in Table I.

TABLE I

Spasmogen	Tissue	Spasmolytic ED_{50} of apocynin (mg/ml)
Acetylcholine bromide (0·01 mcg/ml)	Guineapig ileum	0·16
Histamine dihydrochloride (0·01 mcg/ml)	"	0·21
Barium chloride (0·2 mg/ml)	"	0·39
Oxytocin (0·01 U/ml)	Rat uterus	0·4
Serotonin creatine phosphate (0·01 mcg/ml)	"	0·31

2. *Frog's rectus muscle*.—The drug had no effect on either acetylcholine or KCl induced spasms on this tissue, upto doses of 1 mg/ml.

3. *Perfused frog's heart*.—The drug produced a depressant effect on frog heart with reduction in force of contraction and heart rate in doses of 1–2 mg. The effect was a direct one since it was not blocked by pretreatment with atropine (10 mcg).

4. *Dog's blood pressure and respiration*.—The drug had no significant effect on anaesthetised (pentobarbitone sodium, 35 mg/kg I.P.) dog's blood pressure, heart rate and respiration upto doses of 5 mg/kg I.V.

5. *Biliary secretion in dog*.—In anaesthetised (pentobarbitone sodium, 35 mg/kg I.P.) dog with bile duct cannulated and cystic duct ligated, the drug produced a moderate increase in bile flow in doses of 5 mg/kg I.V. The volume increased twofold by one hour after drug administration and the effect persisted upto 180 min.

6. *Effect on general behaviour*.—The drug in doses of 50 to 100 mg/kg I.P. produced increased motor activity, piloerection, tremors, compulsive gnawing and salivation in albino rats.

SUMMARY

Apocynin, '4-oxy-methoxy-acetophenone, has been isolated from the petroleum ether extract of the roots of *Picrorhiza kurroa* Royle ex Benth., and its structure has been established by chemical and spectroscopic (i.r., n.m.r. and mass) evidences. Apocynin produces a moderate to marked relaxation of rabbit ileum and contracting rat uterus, and antagonises spasms induced by various spasmogens on guineapig ileum and rat uterus. It has a depressant action on frog's heart, and no significant effect on blood pressure. Apocynin possesses choleretic action. It produces a two-fold increase in bile flow in anaesthetised dog by one hour after drug administration and the effect persists upto 3 hours.

Depts. of Medicinal Chemistry and Pharmacology,
Institute of Medical Sciences,
Banaras Hindu University,
Varanasi-5, *July* 22, 1971.

K. BASU.
B. DASGUPTA.
S. K. BHATTACHARYA.
P. K. DEBNATH.

---

1. Chopra, R. N., Chopra, I. C., Handa, K. L. and Kapur, L. D., *Indigenous Drugs of India*, U. N. Dhur & Sons; Calcutta, 1958, p. 181 ; Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glossary of Indian Medicinal Plants*, C.S.I.R., New Delhi, 1956, p. 192.
2. Das, P. K. and Raina, M. K., *J. Res. Ind. Med.*, 1967, **1** (2), 213.
3. Bajpai, H. S., S.S. Hospital, Banaras Hindu University. Varanasi–5 (Personal communication).
4. Rastogi, R. P., Sharma, V. N. and Siddiqui, S., *J. Sci. Ind. Res.*, 1949, **8 B**, 173.
5. Basu, K., Dasgupta, B. and Ghosal, S., *J. Org. Chem.*, 1970, **35** (9), 3159.
6. Finnemore, H., *Proc. Chem. Soc.*, **24**, 171 ; *C.A.*, **2**, 2674.
Wood, *J. Am. Med. Assoc.*, 1953, **43**.
7. Beilstein, **8** (2), 298.
8. Yves Rene Naves, *Helv. Chim. Acta*, **32**, 1351.
9. Beilstein. **8** (1), 614.
10. Adams, R., *J. Amer. Chem. Soc.*, 1919, **41**, 247.

OCCURRENCE OF OOCYTES IN THE KIDNEY OF THE CAT-FISH *HETEROPNEUSTES FOSSILIS* (BLOCH)

ALTHOUGH there are several reports on the occurrence of oocytes in the testes in fishes (*see* Atz)[1], instances citing the presence of oocytes in other tissues are rather scanty[2-4]. During the course of an investigation on the kidney of the cat-fish, *Heteropneustes fossilis*, the occurrence of oocytes in the kidney has been encountered in three instances and the present communication reports the same.

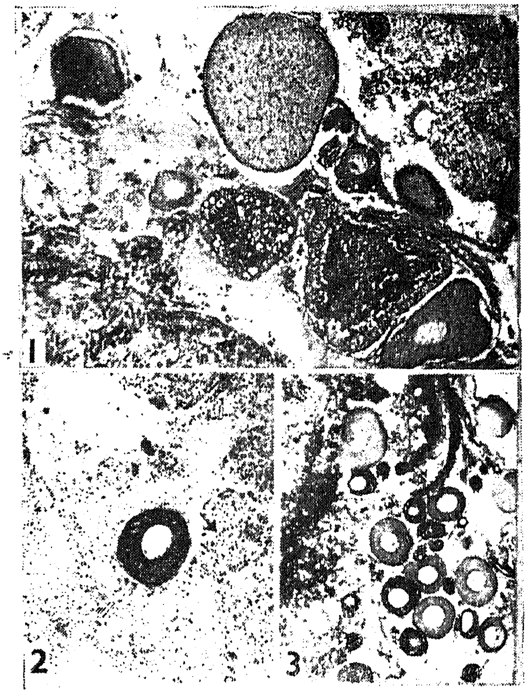
The details of the oocytes found in the kidneys are summarised in Table I.

TABLE I

Serial No.	Length of the fish in cm	Number of oocytes located in the kidney	Average diameter of the oocyte in micra
1	22·3	12	113
2	22·7	4	96
3	21·3	49	90

The kidneys, fixed in Bouin's fluid, were cut at 4 μ thickness and the sections were stained with haematoxylin-eosin, periodic acid-Schiff's reagent (PAS) and iron-haematoxylin.

In the first specimen the oocytes are partly embedded in the kidney and the theca of the mature eggs is closely pressed against the kidney tissue. The various stages of oocytes include the immature, the perinucleolar, the yolk vesicle and the fully mature ones (Fig. 1).



FIGS, 1–3. Fig. 1. Section showing oocytes at different stages, interspersed among the kidney tissue, × 135. Fig, 2. Kidney showing an oocyte at perinucleolar stage. Note the oocyte lined by kindney tissue (arrow shows urinary tubule) on one side and haemopoietic tissue on the other, × 97. Fig. 3. A number of oocytes some of which are completely surrounded by kidney tissue, × 60.

Of the four oocytes present in the kidney of the second fish one is at perinucleolar stage, while the others are immature. The former is lined on one side by kidney tissue and the rest of it is covered by haemopoietic tissue (Fig. 2).

The number of oocytes embedded in the kidney of the third specimen is comparatively more. Most of them are partly embedded in the kidney and a few are lodged deep. Several oocytes are at different stages of maturing phase, while some are at perinucleolar stage. A few oocytes are large and possess nuclei with disintegrating nuclear membrane and rows of vesicles arranged in the peripheral region of the ooplasm (Fig. 3).

The oocytes which are completely enveloped lie closely apposed to the urinary tubules and the glomeruli of the kidney. All the oocytes appear intact and show no signs of degeneration or cyst-formation. A section also shows an oocyte lying close to the corpuscle of Stannius. The stages of the oocytes in the kidney almost correspond to those in the ovary of the fish.

Although the oocytes are aberrantly situated in the kidney, they did not display any degenerative activity. On the other hand the various developing stages are indicative of life and vitality. The plausible explanation for such an abnormality has been suggested by Johnston[2] according to whom some of the primordial germ cells arising from the dorsal lip of the blastopore get 'lost' in the mesenchyme instead of reaching the gonadal primordia which is their true seat of function. A similar explanation may hold true for the occurrence of oocytes in the kidney of the three specimens of *H. fossilis* also.

The authors wish to thank Dr. S. M. H. Khatib, Professor and Head of the Department of Zoology, Nagpur University, for laboratory facilities and encouragement and Mr. C. M. Saroday for his help in photomicrography.

Post-Graduate
Dept. of Zoology,
Nagpur University,
University Campus,
Nagpur, *July* 12, 1971.

NISHIKANT SUBHEDAR.
P. D. PRASADA RAO.

---

1. Atz, J. W., in *Intersexuality in Vertebrates Including Man* (Eds. C. N. Armstrong and A. J. Marshall), Academic Press, London and New York, 1964.
2. Johnston, P. M., *J. Morph.*, 1951, **88**, **471**.
3. Sathyanesan, A. G., *Sci. and Cult.*, **1956**, **22**, **341**.
4. —, *Ibid.*, **1957**, **23**, **203**.

BACTERIOIDS AT THE SITE OF NERVE SEVERANCE IN THE COCKROACH *PERIPLANETA AMERICANA*

IN an investigation on the incidence and peculiarities of the "tumors" of the salivary glands induced by the severance of the recurrent nerve in *Periplaneta americana,* an accumulation of micro-organisms in the haemocytes and lobes of fat bodies at the site of the operations has been found. Within two to three weeks after nerve severance, accumulation of opaque, whitish masses becomes well defined on the lobes of the salivary glands. The insects were normal in behaviour and there was no overfeeding (hyperphagia). In the fat bodies lie the mycetocytes lodging bacterioids of variable size and shape, but in the haemocytes the bacterioids appear to lie free in the cytoplasm. The bacterioid cytoplasm appears granular and faintly dense with patches of reduced electron-opacity. The cell wall of these is well defined, with opaque and lucent layers (Fig. 1) ; fission stages occur in large numbers, with distinctly recognisable mesosomes. Pleomorphic changes are noticeable. In both sexes of *Periplaneta,* but predominantly in the female, stages similar to metamorphosing bacterioids have been recognised, mostly lying in the peripheral cells of the salivary glands. The insects seem not to be affected in their reproduction.

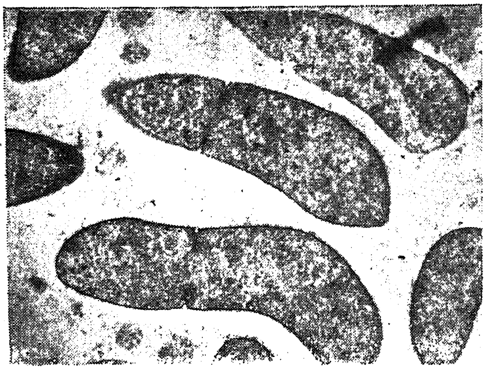


FIG. 1. Bacterioids in the fat body lying adjacent to the site of nerve severance in *Periplaneta americana.* Electron Micrograph. After 16 days of operation, × 38,000.

The bacterioids appear to be *Blattabacterium cuenoti* Hollande and Faure, the type species of the only known symbiote of blattids[1]. The pleomorphs and the metamorphosing forms appear to be similar to the ones recorded by Milburn[2] in *Periplaneta.* These micro-organisms in association with haemocytes, accumulating after nerve severance, indicate foci of inflammation. Hyperphagia has not been observed in the experimental *Periplaneta,* though nerve severance induces this in *Phormia*[3]. The recurrent nerve is both a neural and a neurosecretory pathway[4,5] and so its severance would deprive of the neurosecretory supply to the gut also. It is known that neurosecretory material promotes synthesis of glycogen from sugar[6] and as the salivary glands show a very high concentration of glycogen in electron micrographs, the bacterioids perhaps migrate and metamorphose in their cells. In the experimental animals, the fat bodies show a considerable depletion of glycogen, leading on to adverse effects, and Walker[7] has pointed out that in cockroaches, glycogen depletion following starvation affects the mycetomes leading on to their disappearance.

The accumulation of symbiotic bacteria in haemocytes and the salivary cells, subsequent to the sectioning of the nerve, is recorded for the first time.

Dept. of Zoology, K. K. NAYAR.
Univ. of Kerala, A. C. FERNANDEZ.
Karyavattam,
Trivandrum, *July* 23, 1971.

---

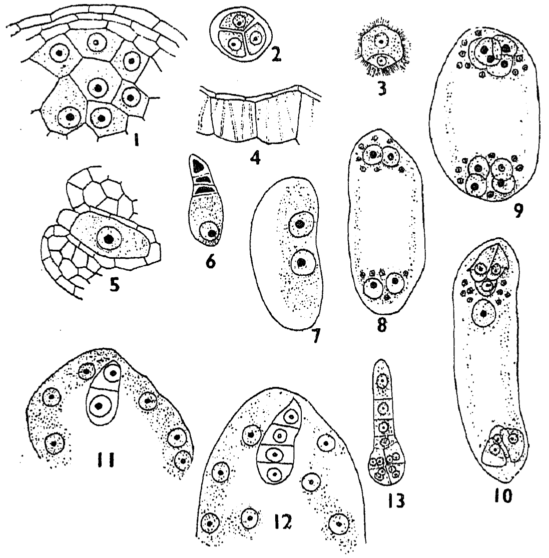
1. Brooks, M. A., *J. insect Pathol.*, 1970, **16,** 249.
2. Milburn, N. S., *Ibid.*, 1966, **12,** 1245.
3. Dethier, V. G. and Gelperin, A., *J. Exp. Biol.*, 1967, **47,** 191.
4. Nayar, K. K., *Zeits. Zellf.*, 1956, **44,** 697.
5. Thomsen, M., *Ibid.*, 1969, **94,** 205.
6. Van Handel, E. and Lea, A. O., *Science*, 1965, **149,** 298.
7. Walker, P. A., *J. Insect Physiol.*, 1965, **11,** 1625.

A CONTRIBUTION TO THE EMBRYOLOGY OF *ANOTIS WIGHTIANA* WALL

THE family Rubiaceae exhibits features of embryological interest[1-6]. The present paper deals with certain aspects of embryology of *Anotic wightiana.*

The transection of a young anther lobe shows that the wall of the anther is made up of epidermis, endothecium, a middle layer, and tapetum (Fig. 1). The tapetal cells are uninucleate throughout and are of glandular type. Pollen mother cells undergo meiosis and form tetrads of spores. The microspore tetrads show tetrahedral arrangement (Fig. 2).

The mature pollen grain is bi-celled with thick exine and thin intine (Fig. 3). The endothecium becomes fibrillar at the time of anther dehiscence (Fig. 4).



FIGS. 1–13. Fig. 1. T.S. of young anther lobe showing wall layers and microspore mother cells, × 500. Fig. 2. Tetrahedral arrangement of microspores. Fig. 3. Two-celled pollen grain, × 750. Fig. 4. Fibrillar endothecium, × 225. Fig. 5. Megaspore mother cells, × 500. Fig. 6. Linear tetrad of megaspores, × 500. Figs. 7–10. Stages in the development of embryo-sac, × 500. Fig. 11. First division of egg, × 500. Fig. 12. Filamentous pro-embryo of four cells, × 500. Fig. 13. Octant stage of embryo, × 500.

The ovary is inferior, bicarpellary, bilocular with two hemianatropous ovules in each locule. The ovules are unitegmic, tenuinucellate, on axile placenta. The nucellus can be classified under the *Oldenlandia*-type[1].

A single hypodermal archesporial cell is differentiated, which directly functions as megaspore mother cell (Fig. 5). The megaspore mother cell undergoes two meiotic divisions to give rise to linear tetrad of megaspores (Fig. 6). Of the four megaspores, the chalazal one becomes functional and upper three degenerate. The nucleus of the functional megaspore undergoes three mitotic divisions to form an 8-nucleate embryo-sac (Figs. 7–10). Starch grains begin to appear at 4-nucleate embryo-sac stage. In the mature embyo-sac the synergids are pear-shaped and are beaked, and egg cell is ovoid. The antipodals are organised as cells, large and of equal size. The secondary nucleus is situated very near the egg.

Fertilization is porogamous. The antipodals degenerate after fertilization as in *Knoxia*[6], *Ophiorrhiza*[3], *Oldenlandia*[2,6], *Pavetta*[1].

The endosperm is *ab initio* nuclear.

The fertilized egg divides transversely producing the terminal cell *Ca* and basal cell Cb. The cell Cb by two transverse divisions gives rise to a row of four cells *d*, *f*, *n*, *n′*. *Ca* then divides to form quadrants and octants (Figs. 11–13). The embryogeny conforms to Solanad type. The suspensor is short constituting of 4 cells.

My thanks are due to Prof. S. Shamanna for encouragement and to Rev. Fr. A. P. Menezes, S.J., Principal, for providing me the facilities. My thanks are also due to Mr. A. S. Rao, Regional Botanist, B.S.I., for sending me the fixed material, and to the U.G.C. for financial assistance.

Department of Botany, G. SHIVARAMIAH.
St. Joseph's College,
Bangalore-1, *May* 8, 1971

---

1. Fagerlind, F., *Acta Horti Bergiani*, 1937, **11**, 195.
2. Farooq, M., *Curr. Sci.*, 1958, **22**, 280.
3. Gopinath, P. M. and Chennaveeraiah, M. S., *J. Karnatak Univ.* (*Dharwar*) *Sci.*, 1961, **6**, 61.
4. Lloyd, F. E., *Mem. Torr. bot. Cl.*, 1899, **8**, 1.
5. Raghavan, T. S. and Rangaswamy, K., *J. Indian bot. Soc.*, 1941, **20**, 341.
6. Shivaramiah, G. and Ganapathi, P. S., *Curr. Sci.*, 1961, **30**, 190.

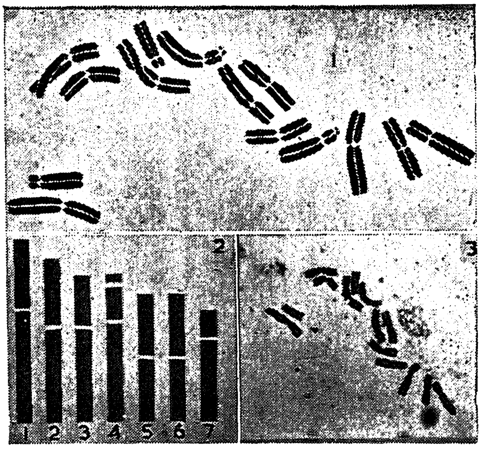
A DIPLOID *CHLOROPHYTUM ORCHIDASTRUM* FROM GHANA (AFRICA)

THE genus *Chlorophytum* Ker-Gawl is represented by about forty-two species of evergreen perennials widely distributed in tropical and sub-tropical regions of the world (Chittenden, 1965, 1969). Thirteen species of the genus are reported to occur in the Indian subcontinent, a few of which are apparently endemic (Hooker, 1892 ; Santapau and Fernandes, 1955). Cytologically the species fall into two series in respect of their chromosome number, one with seven as basic and the other with eight. Of these, the species *C. orchidastrum* Lindl is allopatric and reports on its cytology have come from different countries. These show that the species falls under the 7 basic series and reveals an interesting situation with respect to its distribution. Baldwin and Speese (1951) working on the cytogeographical aspects of *Chlorophytum* in Liberia have reported the chromosome number of *C. orchidastrum* as $2n = 28$ and have considered the species a tetraploid with seven as the basic number. Larsen (1963) has reported the chromosome number of the same species from Thailand as

$2n = 56$. Sheriff (1967), investigating the cytology of Indian Chlorophytums, has recorded the chromosome number of the species collected from southern and central parts of India as $2n = 42$ and has considered it a hexaploid. These reports evidently reveal that the species forms a polyploid complex and exists at different levels of polyploidy in different countries either as tetraploids (Liberia), hexaploids (India) or octoploids (Thailand). No diploids have been found and reported so far. The present report of diploids with $2n = 14$ in the species is, therefore, of significance.

Living plants were procured from Ghana through the Government Botanical Gardens, Bangalore (Collection No. P. 11). The plants grow luxuriantly under the green-house conditions in Bangalore and flower and fruit profusely. They show phenotypic similarities as well as differences with their Indian counterparts, both in vegetative and floral characters. The somatic chromosome number was determined from root tips pretreated with 0·05% aqueous colchicine at room temperature and stained with the acetic-orcein squash technique. The squashes were made permanent with *n*-butyl alcohol-acetic acid series procedure, and using euparal as the mountant.

The somatic chromosome number is $2n = 14$. The chromosomes are generally long and the karyotype appears symmetrical. Figure 1 is the camera-lucida drawing of the karyotype and Fig. 3 is its photomicrograph. Figure 2 is the idiogram of the somatic complement. There is one pair of chromosomes (fourth in the idiogram) with terminal satellites on the short arm. Three pairs (first, second and third) are submetacentric. Two pairs (fifth and sixth) of metacentric chromosomes looking identical and only one pair (seventh) with subterminal primary constrictions are noteworthy features. The length of the chromosomes ranges between 6·8 μ and 11·6 μ and the computed absolute length is 62·2 μ.



FIGS. 1-3. Fig. 1. Karyotype of *Chlorophytum orchidastrum* ($2n=14$), × 1,450. Fig. 2. Idiogram of the somatic complement. Fig. 3. Photomicrograph of the karyotype, × 725.

The discovery of the occurrence of diploids with $2n = 14$ from Ghana in the present work is significant in that it provides and establishes an important link hitherto unknown in the polyploid complex. It also throws light on the pattern of cytological evolution within the taxon in different geographical areas of the world: diploids in Ghana, tetraploids in Liberia, hexaploids in India and octoploids in Thailand. It is also indicative that the chromosomal evolution in the taxon is through polyploidy associated with structural changes.

The authors wish to thank Professor M. Nagaraj for his interest in this work and the facilities provided.

Department of Botany, A. SHERIFF.
Bangalore University, USHA GOPALA RAO.
Central College, Bangalore, India,
July 19, 1971.

---

1. Baldwin, J. T. and Speese B. M., "Cytogeography of *Chlorophytum* in Liberia," *Amer. Jour. Bot.*, 1951, **38**, 153.
2. Chittenden, F. G., *Dictionary of Gardening*, Oxford, Clarendon Press, 1965.
3. —, *Ibid.* (Supplement), 1969.
4. Hooker, J. D., *Flora of British India*, Vol. VI, London, 1892.
5. Larsen, K., "Studies on the flora of Thailand 14: Cytological studies in vascular plants of Thailand," *Daerck Bot. Arkiv.*, 1963, **20**, 211.
6. Santapau, H. and Fernandes, K R., "A new species of *Chlorophytum* from Salsette island," *Jour. Bomb. Nat. Hist. Soc.*, 1955, **52**, 897.
7. Sheriff, A., "Cytological and cytotaxonomic studies in certain members of Liliaceae," *Ph.D. Thesis*, Bangalore University, 1967.

CYTOTAXONOMY OF A DIPLOID *CHLOROPHYTUM ORCHIDASTRUM* LINDL.

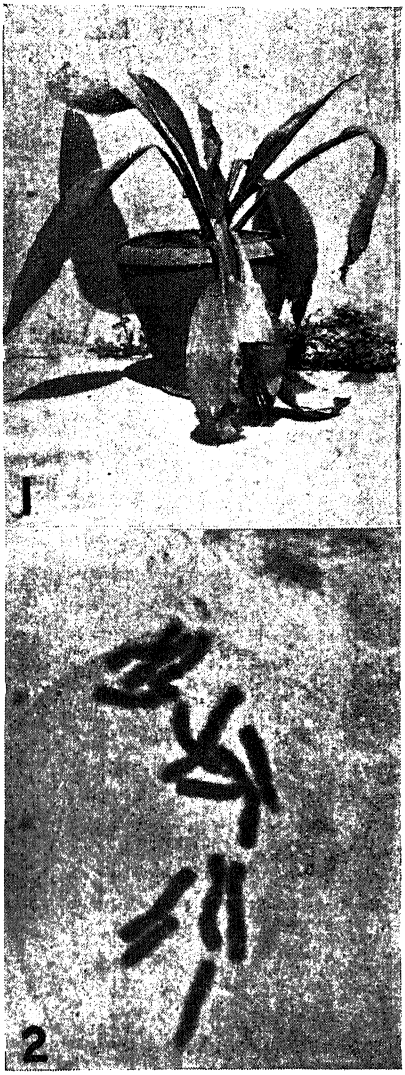
Chlorophytum orchidastrum Lindl is a perennial herb belonging to the tribe Asphodelae of the family Liliaceae (Hooker, 1894). It occurs wild in several parts of tropical Africa, especially Sierra Leone, Liberia, Upper Guinea and Nigeria (Thiselton-Dyer, 1898). In India, it has been reported from Deccan Peninsula from the Concan southwards to Travancore (Hooker, 1894) and throughout Western Ghats upto 3,000 ft and Rampa Hills (Gamble, 1928). The present investigation deals with the karyomorphology of this species for which the material was obtained from Ghana through the courtesy of the Director of Horticulture, Lal Baugh Botanical Gardens, Bangalore, to whom the authors are indebted.

Excised root tips were pretreated with 0·1% colchicine for 1½ hours and stained as per Fuelgen's schedule after fixing in 1 : 3 acetic alcohol. The slides were made permanent by passing them through the 1 : 1 butanol and acetic acid, and butanol series, and mounted in euparal. The chromosomes have been arranged in the order of increasing length of the short arm.

Chlorophytum orchidastrum shows a fibrous root system with swollen tuber-like root fibres. The stem bears many leaves which possess distinct 6–9″ long petioles. They are membranous, elliptic-oblong, lanceolate, acuminate, 10–12″ long and 2–3″ broad in the middle. They gradually narrow at both the ends (Fig. 1). The peduncle is slender and 1–2 ft long with many lax racemes, each 4–6″ long with ovate bracts at the base. Flowers are in distant pairs, with pedicels articulated at the middle. Perianth segments are greenish-white and narrow. Anthers are as long as the filaments and the capsules are two-lobed at the tip.

The chromosome number is found to be $2n = 14$. The karyotype shows chromosomes possessing sub-terminal, sub-median, near median and median constrictions (Figs. 2, 3). There are two pairs of chromosomes with sub-terminal constrictions and an arm ratio between 1 : 3 and 1 : 4; two pairs with sub-median constrictions and an arm ratio of 1 : 2 and three pairs with median and near median constrictions. The second pair of chromosomes shows satellites (Figs. 2, 3). The smallest (first pair) and the largest pair (last pair) are easily distinguishable in the karyotype (Figs. 2, 3).

Previous work on the genus *Chlorophytum* indicates the basic chromosome number to be 7 and 8 in different species (Sherieff, 1957; Thomas, 1960; Baldwin and Speese, 1951; Boraiah, 1966, 1967). Polyploids have also been reported as of frequent occurrence in this genus (Baldwin and Speese, 1951; Sherieff, 1957; Sharma and Chaterjee, 1958; Larsen, 1963). *Chlorophytum orchidastrum* is one such reported as a tetraploid with $2n = 28$ from Liberia and neighbouring States (Baldwin and Speese, 1951). But the present investigation reveals this species to be a diploid. However, in the tetraploid species, no satellites have been reported by Baldwin and Speese (1951). A comparison of the diploid and the tetraploid species reveals that one of the genomes of the tetraploid is



FIGS. 1-2. Fig. 1. Photograph of the entire plant. **Fig. 2.** Photomicrograph showing the somatic metaphase chromosomes, $2n = 14$.

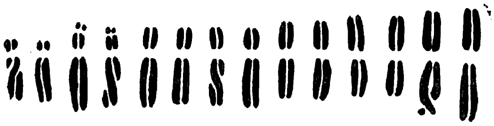


FIG. 3. Somatic metaphase chromosomes of *Chlorophytum orchidastrum* Lindl., × 1,000.

morphologically similar to the diploid one except for the satellites. The geographical distribution of the tetraploid taxon indicates that it is found growing in the neighbouring States in West Africa, *viz.*, Nigeria, Guinea, Liberia and Sierra Leone (Baldwin and Speese, 1951). It is likely that this is also found in Ghana with the diploids overlapping in distribution. It is possible that the tetraploid taxon is an allotetraploid with one of the genomes derived from a diploid, as there are similarities in geographical distribution, morphology of the plants and morphology of the chromosomes.

The authors are grateful to Dr. R. Narayana, Director of Instruction (BS & H), University of Agricultural Sciences, Bangalore-24, for reading through the manuscript and encouragement.

Department of Botany, G. BORAIAH.
Univ. of Agricultural TASNEEM FATHIMA.
Sciences,
Bangalore-24, *September* 11, 1971.

---

1. Baldwin, J. T. and Speese, B. M., *Amer. J. Bot.*, 1951, **3** (2) 153.
2. Boraiah, G., *Curr. Sci.*, 1966 **35,** 314.
3. —, *Mys. J. Agri Sci*, 1967, (1)4, 292.
4. Gamble. J S., *Flora of Presideney of Madras*, 1928, **3**. 1058.
5. Hooker, J. D., *The Flora of British India*, 1872, **6,** 299.
6. Larsen, K., *Danst. Bot. Arkiv.*, 1963, **20**. 211.
7. Sharma, A. K. and Chaterjee, A. K., *Genet. Iberi.*, 1958, **10,** 149.
8. Sherieff. A., *J. Indian Bot. Soc.* 1957, **36** (2), 232.
9. Thiselton-Dyer. W. T., *Flora of Tropical Africa*, 1898, **7**, 500.
10. Thomas. K. J., *Cytologia*, 1960, **25,** 97.

A NOTE ON THE EFFECT OF X-IRRADIATION OF GROWING EMBRYOS IN RICE

A variety of biological manipulations has been attempted in a wide range of organisms of which treatment at different ontogenetic stages is considered to be one of the effective ways of achieving directed mutagenesis. Using this approach, attempts to alter the spectrum and frequency of mutation in a predictable manner have been made in rice with limited success[1-3]. Saric[4] and later Merricle and Merricle[5] working with barley reported that irradiation of differentiating embryos at different developmental stages showed differential response. A preliminary study was made in the *japonica* rice variety Tainan-3 to assess the relative sensitivity to X-rays of different developmental stages after fertilization. Each spikelet immediately after fertilization was marked with different colours to distinguish it from the rest of the spikelets and irradiated with 2 KR of X-rays at the desired age of development. The seeds from the plants thus treated were collected and sown in pots. Data on sensitivity as measured by various indices in the M_1 are summarised in Table I and Fig. 1.

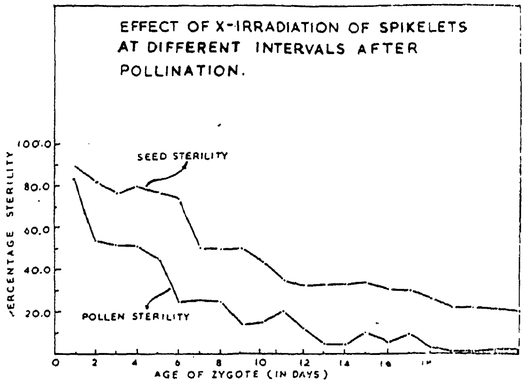


FIG. 1

TABLE I

Effect of X-irradiation (2 KR) of spikelets at different intervals after pollination

Treatments (No. of days after pollination)	Germination % of control	Survival % of control	Shoot length on 10th day (% of control)
Control	100·00	100·00	100·00
1	92·93	77·64	90·22
2	92·63	71·25	91·11
3	91·63	88·93	91·18
4	94·02	91·53	90·25
5	9[illegible]·94	86·66	91·11
6	95·84	92·82	94·14
7	94·11	92·85	93·78
8	93·60	94·33	96·67
9	98·13	96·96	92·89
10	98·42	96·96	92·95
11	97·77	100·00	97·33
12	9[illegible]·35	99·14	96·00
13	97·17	94·92	97·78
14	99·31	98·66	97·00
15	99·31	100·00	97·67
16	98·89	99·64	97·78
18	100·00	98·14	98·22
19	99·20	100·00	98·33
20	98·86	99·64	98·33
25	99·40	100·00	99·00
26	99·03	98·64	98·95
27	99·10	100·00	98·78

The data suggested no appreciable reduction in germination and growth rate of seedlings in the progenies of embryos treated at 1 to 27 days after fertilization while a marked reduction in survival was exhibited by the 1 and 2 days-old treated progenies. However, pollen and seed fertilities which are considered to be one of the most dependable indices to estimate the genetic effect of the treatment, showed a marked reduction with early embryo stages. The one and two days old treated progenies, in particular, showed the highest reduction of 82·51 and 53·48% respectively of pollen fertility after which there was a progressive reduction in the effect. Seed fertility also showed a similar trend but the reduction was relatively higher as compared to the corresponding reduction values in pollen fertility. These are in conformity with the findings of Saric[4] and Merricle and Merricle[5] in barley. The M_2 grown from the seeds of M_1 indicated very poor germination in the early embryo treated progenies, while relatively better germination in the late embryo treated ones thus showing possible induction of mutations for latent zygotic lethality in the early embryos. The progeny scored for chlorophyll deformity showed stray mutations in the early embryo treated progenies and none in the late embryo treated ones, possibly due to the low effectiveness of the dose administered in the late and high lethality in the early-embryo treated ones. The study however, left no opportunity for the estimation of change in the spectrum. Given standardised dose and reduction in sterility through treatment modification there is every possibility that the spectrum of mutations could be altered by subjecting the differentiating tissues to specific mutagens.

Nuclear Research Laboratory,
Ind. Agri. Res. Inst.,
New Delhi, *July* 23, 1971.

K. Palanichamy.
V. P. Singh.
E. A. Siddiq.

---

1. Kawai, T., *Gamma Field Symposia*, 1962 **1**, 31.
2. — and Inoshita. T., *Radiation Botany*, 1965, **5**, 233.
3. Siddiq, E. A., Ismail, M. A. and Swaminathan, M.S. *Proc. Symp. Radiations and Radiomimatic Substances in Mutation Breeding 1969—BARC Trombay*, 1970, p. 274.
4. Saric. M R., *Proc. 2nd Intern. Conf. Peaceful Uses of Atomic Energy*, 1958, 27. 233.
5. Merricle, J. W. and Merricle, R. P., *Brookhaven Symp. Biol.*, 1961, **14**, 262.

A NEW BACTERIAL DISEASE OF RAGI, *ELEUSINE CORACANA* (LINN.) GAERTN., IN MYSORE STATE

In the course of investigations the authors came across a serious disease of ragi, *Eleusine coracana* (Linn.) Gaertn., in and around Bangalore District. Detailed studies revealed this disease to be due to a bacterium. Our studies on the disease and the pathogen involved are briefly reported here.

In most cases old leaves are the first to be affected followed by the younger ones. Brown coloration of the leaf sheath from base upwards is seen. The affected portion of the lamina invariably involves the midrib and appears straw coloured. This symptom spreads to about three-fourths the lamina and then abruptly stops or in some cases reaches the leaf tip. Occasionally thin strips of infected areas are seen to proceed along the margin of the lamina, leaving the central portion, including the midrib, healthy. The bacteria are readily detected in the phloem vessels. Infected plants can be recognised from distance by characteristic drooping of the leaves.

Infected culms show a light brown discoloration along one side. In some cases this discoloration begins from the base, but in most instances it begins two to three inches above the base and extends to the leaf sheath proper. There is, however, no apparent reduction in girth or turgidity of the affected culms as compared to the healthy ones.

Plants less than a month old are usually free from the disease. The bacterium is systemic and soil borne.

Employing nutrient agar a pure culture of the bacterium was obtained. Koch postulates were performed and the culture proved to be the pathogen. When inoculated on maize (*Zea mays* Linn.) the bacterium induced mild infection.

The bacterium is a short rod, found singly or in pairs, measuring 0·83–2 μ by 0·31–0·42 μ, capsulated with one or two monotrichous flagella, Gram-negative, non-spore forming and non-acid fast.

The bacterium strongly hydrolyses starch, produces acid but no gas from glucose, turns plain milk alkaline and shows mild lipolytic activity. The bacterium does not liquefy gelatin, reduce nitrate, answer vogues Proskauer and Methyl red test, is negative to indole production and casein hydrolysis.

The symptoms and pathogen of this disease do not resemble the bacterial disease of ragi described by Rangaswami *et al.*[1]; the only bacterial disease so far reported on ragi.

The morphological and physiological characters of this pathogen suggest that it is a species of the genus *Pseudomonas*. We consider this to be a new disease and propose to name the pathogen as *Pseudomonas eleusineae* Billirnoria and Hegde, sp. nov.

Thanks are due to the University of Agricultural Sciences, Hebbal, Bangalore, for granting permission to the senior author to publish his thesis.

Dept. of Mycology and Plant Pathology,
University of Agricultural Sciences,
Hebbal, Bangalore,
July 10, 1971.

K. N. BILLIMORIA.
R. K. HEGDE.

---

1. Rangaswami, G., Prasad, N. N. and Eswaran, K. S. S., *Indian Phytopath.*, 1961, **14**, 1051.

CYST FORMING NEMATODE (*HETERODERA* SP.) ATTACKING *SESAMUM ORIENTALE* IN INDIA

OF the sesamum cultivation throughout the world, India shares 44·6% of the area and 26% of the total produce. Within India, about 82,500 metric tons of annual produce come exclusively from Rajasthan State. Of late, the sesamum production in the State has however shown a downward trend especially in those five districts where it is grown on a commercial scale. Earlier survey of nematode attack on this crop[1,2] brought out a prevalence of species of *Meloidogyne* and *Pratylenchus*. At no time, a presence of cyst-forming nematode could be suspected. On the present occasion the authors nevertheless observed certain sesamum fields, in the district Chittorgarh, showing plentiful infestation by cyst nematode. This association of *Sesamum orientale* with a *Heterodera* species is new to nematological studies.

The cyst-infested sesamum plants showed a relative stunted growth, a sparse root-system with bunchy appearance, and deficient pod-production. In the instances of a particularly heavy cyst-infestation the plant growth was strikingly checked and a few, poor quality pods were all that formed. The nematode cysts attached to the root-system (including the rootlets) were found as deeply embedded, and when removed from a root portion left a crater-shaped hollow on it.

Parasite.—The developed cysts of the nematode are brown, of average size, 576 × 361 μ (the length-breadth ratio being 1·59 : 1); these ambifenestrate cysts have bullae away from the vulva and the subcrystalline layer absent. Egg-sac is large (Fig. 1), having upto 100 eggs inside. The nematode larvae are (average) 418·1 μ long with a stylet 23·4 μ size and the knobs anteriorly pointed. Lateral lines are four; clear portion of tail is equal to stylet length. Male adults of the species are 1·2 mm in length, having 23 μ long spear and 28 μ long bidentate spicule.

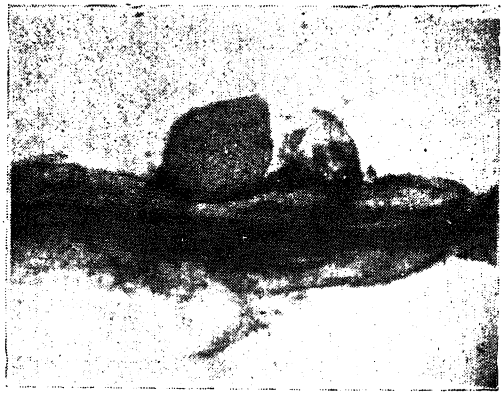


FIG. 1. *Heterodera* cyst attached to a sesame rootlet.

The *Heterodera* species observed differs morphologically from the hitherto described species of the genus; a detailed taxonomic study on this is under way.

Agricultural Experiment Station,
University of Udaipur,
Udaipur (Raj.), India, *July* 7, 1971.

B. S. YADAV.
A. C. VERMA.

---

1. Yadav, B. S., Varma, M. K. and Naik, S. M., *Curr. Sci.*, 1970, **39**, 470.
2. — and Naik, S. M., *Labdev J. Sci. Tech.*, **1966**, **4** (3), 184.

A NEW FRUIT ROT OF PAPAYA

WHILE making survey of pre- and post-harvest rots of fruits of papaya (*Carica papaya* L.) around Jabalpur, an undescribed rot at pre-harvest stage was observed. The isolations from the diseased fruits consistently yielded a species of *Phomopsis* which was later identified as *Phomopsis caricae papayae* Petrak and Cif.

The diseased fruits developed a water-soaked spot on the surface of the fruit which increased in size towards maturity. The whole area became soft and pulpy and gave the appearance of soft rot. The rotted portion became depressed, dark brown to black in colour and cracked at a later stage. The area surrounding the diseased portion of the fruit developed water soaking. In fruits where further increase of the diseased area was checked the area surrounding the rotted portion became raised and turned white (Fig. 1). The fruits were found to get infected at all stages of their growth till ripening.

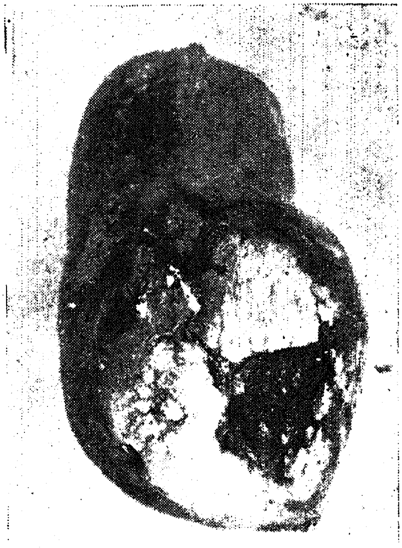


FIG. 1. Fruit rot of papaya caused by *Phomopsis caricae papayae.*

The pathogenicity of *P. caricae papayae* on papaya fruits was proved under laboratory as well as in field conditions. The fungus grew very slowly on potato-dextrose-agar medium and resulted in a colony with rough edge. The hyphae were hyaline upto 3–4 days, later turned subhyaline, pale yellow, and then yellowish-brown. Very few conidiophores and conidia were formed on the medium. The conidiophores were rod-shaped, tapering towards the apex and measured 6·6–14·5 μ in length. Conidia were mostly rod-shaped, nonseptate, hyaline, 3·33–10·1 × 1·6–2·44 μ. Pycnidia appeared after three weeks as tough, irregularly flask-shaped, black, ostiolate structures measuring 132·6–321·5 μ in diameter and were submerged in the medium upto half of their length.

Although the fungus was first reported by Petrak and Cifarrii in 1930[1] on the dried stems of papaya in association with *Colletotrichum*, the rot of papaya fruits caused by *Phomopsis caricae papayae* is a new record.

The authors wish to thank the Director of the Commonwealth Mycological Institute, Kew, England, for the identification of the pathogen and Dr. L. K. Joshi, Professor and Head, Department of Plant Pathology, J.N.K.V.V., Jabalpur, M.P., for his interest and help.

Dept. of Plant Pathology, O. D. DHINGRA.
Jawaharlal Nehru Krishi M. N. KHARE.
Vishwa Vidyalaya,
Jabalpur, M.P., *July* 12, 1971.

---

1. Petrak, F. and Ciferrii, R. *Ann. Mycol.*, 1930, **28**, 377.

SEMINAR ON BIOGEOGRAPHY AT THE FRENCH INSTITUTE, PONDICHERRY

A seminar on Biogeography was held in the French Institute of Pondicherry, from 11th to 15th October, 1971. This was inaugurated by Prof. Dr. J. Filliozat, Director of the French Institute.

The following topics were discussed: Inter-relations between organisms and the physical environment (climate, soil), plant geography, cytogeography, palynology.

Among the participants were specialists from Universities of Annamalai, Mysore and Waltair, from Forest Research Institutes of Dehra Dun and Coimbatore and forest officers from W. Bengal, Mysore, Madras State and Auroville.

The seminar in addition to being of scientific interest, brought together experts from various disciplines to share their ideas and to establish closer co-operation for a better understanding of the present environment that may benefit man.

REVIEWS AND NOTICES OF BOOKS

Rothamsted Experimental Station—Report for 1970. (Obtainable from The Librarian, Rothamsted Experimental Station, Harpenden, Herts, England), Part I, Pp. 385; Part II, Pp. 259. Price for both parts £ 2.00.

As in the last two previous years the *Report of the Rothamsted Experimental Station for the Year* 1970 is issued in two parts. Part I describes the work of the year and lists published papers. Part II contains papers by members of the Rothamsted staff.

The General Report by the Director, Sir Frederick Bawden, in Part I, surveys briefly the Station's work in the laboratories and in the farms during the year and deals in the main with work on the semi-dwarf wheat derived from the Japanese variety Norin 10 and results of studies on crop growth and yield in controlled environment rooms (C.E. Rooms). In dealing with soil structure and fertility Sir Frederick incidentally refers to the Report of the Agricultural Advisory Council, U.K., entitled *Modern Farming and the Soil* which according to him "is rather depressing reading for research workers, because the authors seem more impressed by hearsay than by the results of controlled experiments".

One of the continuing works in the Physics Department in controlled environment studies is that on the respiration of cotton leaves during photosynthesis. Results of experiments lead one to infer that there are two respiratory processes that occur during photosynthesis, one dependent on temperature and independent of oxygen concentration, and the other with exactly the contrary attributes.

The Chemistry Department reports that the long-term experiments on the evaluation of phosphate residues in soil show that it is false economy to use minimal dressings of phosphate because any surplus accumulates in soil and can greatly benefit later crops. Thus the accumulation of P in the Station's arable soils could be responsible for the more than one-fifth increase in barley yields during the last quarter century. On the application of fertilizers and herbicides, the report says, that for all crops, yields were larger with 'Nitro-Chalk' than with liquid fertilizer. Further it is found that the effectiveness of neither the liquid fertilizer nor the herbicide was diminished by applying both together, and indeed in this way the herbicide may be more effective than when sprayed separately. It may again be an advantage by making weeds more susceptible to herbicide.

The Botany Department reporting on the effects of water stress on growth recommends the use of polyethylene glycol (PEG) solutions in radiation-cooled growth cabinet as this provides a well-controlled and stable system suitable for studies of water stress in growing plants. The report contains also results of studies on growth substances and growth regulators, especially IAA and CCC.

Study of leaf proteins has become a practical part of agricultural research, and the Biochemistry Department reports work on potential large-scale preparation of leaf protein from winter wheat, rye, cocksfoot, mustard and fodder radish all of which can synthesize extractable protein at more than 8 kg/ha/day.

Two of the pyrethroids, synthesized in the Insecticides and Fungicides Department, namely, resmethrin (NRDC 104) and bioresmethrin (NRDC 107) are now being produced commercially. Further work indicates that compounds can be synthesized that act faster and are more insecticidally active than the natural pyrethrins; also other compounds can be made that are more selective in their action.

The Report contains the Abstracts of more than 300 papers published by the various departments of the Station during the year.

The twelve special papers in Part II, contributed by members of the Rothamsted staff, include "the chemical composition of water from land drains at Saxmundham and Woburn, and the influence of rainfall upon nutrient losses"; "the accumulation of organic matter in soil left uncultivated", "virus diseases of the honeybee" and "docking disorder and root ectoparasitic nematodes of sugar-beet".

A. S. G.

Pulse Crops of India. Editor: P. Kachroo. (Indian Council of Agricultural Research, New Delhi), 1970. Pp. 334. Price Rs. 15·50.

Pulses form an essential item of Indian diet and they supply the necessary proteins for the large vegetarian population. The cultivation of pulse crops has been the mainstay of Indian agriculture from time immemorial. It is common for one or the other of the pulse crops to be grown as a rotation crop as it improves the soil fertility better than is possible by keeping the land fallow. In India about one-fifth of the total area of foodgrain crops is under pulse cultivation.

The book under review gives comprehensive information on the botany, genetics, cytology, cultivation, production, uses, promising varieties, diseases, pests, etc., of the different pulse crops which include most of the major and minor pulses cultivated in India. The ten chapters in the book are contributed by specialists who have made life-long studies on the subject of their topic in the fields and in the laboratories. The pulses dealt with are red gram, gram, the Phaseolus group, soybean, cluster bean, cowpea, beans, peas, etc.

The book will interest not only research workers and teachers but also the practical agriculturists and laymen. A. S. G.

Communication System. By B. P. Lathi. (Wiley Eastern Private Ltd., Publishers, J-14, South Extension 1, New Delhi-49), 1971. Pp. xi + 431. Price Rs. 20·00.

This text of Communication Systems is the first Wiley Eastern Reprint of the original U.S., Edition of 1968 by the author of the popular book *Signals, Systems and Communication*. The purpose of the book is to introduce the student to communication systems and the broad principles of modern communication theory at an early stage in the under-graduate curriculum. It begins with the study of communication systems through chapters on signal analysis, signal transmission and power density spectra, amplitude modulation, angle modulation, and pulse modulation, and then passes on to noise, performance and information transmission. The final chapter deals with the elements of digital communication.

Throughout the book, the emphasis is on a physical appreciation of the concepts rather than mathematical manipulation. The book is self-contained and will be easily understood by beginning students of communication engineering.

This paper-back Indian Reprint priced moderately should enable course student on the subject to own his copy of this useful text-book.

A. S. G.

Statistics—A Foundation for Analysis. By A. Hughes and D. Grawoig. (Addison-Wesley Publishing Co., Inc., West End House, 11, Hills Place, London, W. 1, England), 1971. Pp. xvi + 525. Price £ 3.60.

This book is addressed primarily to an audience of advanced under-graduate or beginning graduate students in business and economics. The text provides a reasonably comprehensive discussion of the more commonly used statistical methods and their application in business context.

The opening chapters are devoted to elements of probability theory and probability models. Then follow chapters on sampling, statistical estimation, means, proportions, variances, analysis of variance, regression analysis and correlation analysis. The last two chapters discuss nonparametric statistics and decision theory. The book abounds in worked-out examples and problems which will enable the student to understand the methodology of statistics and its application to practical situations.

The book provides a text which will be useful both to the teacher and the student.

A. S. G.

Rock Weathering. By Dorothy Carroll. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xv + 203. Price $ 15.00.

Soil science as a practical subject is as old as agriculture itself. Books on soil science are mainly written for agriculturists and land users, and so they are generally descriptive in nature dealing more with classification of soils and their crop-production capacities. The treatment of the subject from a geological point of view, with emphasis on the evolution of soils and the reasons governing their composition and form, is of more fundamental importance in understanding soil depletion and soil development. From this aspect the present publication on rock weathering processes and their results by one who has devoted long years of study to the subject will be a welcome addition to the literature on soil science.

This book, which is one in the series "Monographs in Geoscience", attempts at bringing together the results of research from several disciplines to explain the fundamental geochemical principles of weathering and soil formation. It presupposes on the part of the reader some knowledge of rocks, minerals, chemistry and geochemistry. The book is readable and contains up-to-date information on various aspects of rock weathering and soil formation. A. S. G.

Thermal Comfort—Analysis and Applications in Environmental Engineering. By P. O. Fanger. (Published by Danish Technical Press, 4, Skelbaekgade, DK 1717, Copenhagen V, Denmark), 1970. Pp. 240. Price: Danish kr. 76.50; U.S. $ 10.20 + postage.

This book is mainly based on recent comprehensive research done during the last five years in Denmark and in the U.S. Dr. Fanger initiated this study recognizing the importance of thermal comfort for man and the various environmental engineering factors involved in providing it. The results of these studies are incorporated in this book, which is the first of its kind on the subject.

A rational basis is set up for the establishment of thermal comfort conditions, for the evaluation of thermal environments in practice and for the carrying out of thermal analyses of enclosures based on comfort criteria.

The study of thermal comfort touches on many disciplines, including heat and mass transfer, thermal physiology, psychophysics, ergonomics, biometeorology, architecture and textile engineering. The book takes into consideration all these aspects and presents an integrated account. The results of studies are presented in such a way as to be readily useful to environmental engineers and workers in industries connected with heating and air-conditioning.

The book is excellently produced and contains a number of charts, tables and literature references. A. S. G.

Sepctroscopic Tricks (Vol. 2). Edited by Leopold May. (Plenum Publishing Corporation, 227, West, 17th Street, New York, N.Y. 10011), 1971. Pp. xiii + 374, Price $ 9.50.

"Spectroscopic Tricks" was introduced in 1959 as a special section in the journal *Applied Spectroscopy*. Its purpose was to provide a means of communicating information on new devices, modifications of existing apparatuses, and other items of this nature of interest to working spectroscopists. *Applied Spectroscopy* continues this useful section, but now under the title "Spectroscopic Techniques".

A collection of these contributions which appeared in *Applied Spectroscopy* during the years 1959 through 1965 formed Volume 1 of this unique series, *Spectroscopic Tricks*, published by the Plenum Publishing Corporation.

The present Volume 2 in this series covers the period 1966 through 1969, and the selection includes topics concerning emission and atomic absorption, infrared, mass spectroscopy, nuclear magnetic resonance, Raman spectroscopy, Ultraviolet and visible and X-ray spectroscopy.

This series will be a useful reference source to experimental spectroscopists.

A. S. G.

Books Received

Brain Displacements and Deformations. By S. M. Blinkov and N. A. Smirnov. (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1971. Pp. xi + 371. Price $ 25.00.

Cell Membrane Transport. By Arnost Kotyk and Karel Janacek. (Plenum Pub. Corpn., New York, N.Y. 10011), 1971. Pp. xvii + 498. Price $ 35.00.

Contemporary Brain Research in China—Selected Paper on Electrophysiological Topics. Translated from the Chinese and Edited by S. Barlow. (Plenum Pub. Corpn., New York, N.Y. 10011), 1971. Pp. vii + 112. Price $ 15.00.

Vacuum Microbalance Techniques (Vol. 8). Edited by A. W. Czenderna. (Plenum Pub. Corpn., New York, N.Y. 10011), 1971. Pp. xiii + 251. Price $ 22.50.

Organic Fluorine Chemistry. By Milos Hudlicky. (Plenum Pub. Corpn., New York, N.Y. 10011), 1971. Pp. xiii + 198. Price $ 16.50.

The Nervous System and Electric Currents (Vol. 2). Edited by N. L. Wulfsohn and A. Sances, Jr. (Plenum Pub. Corpn., New York, N.Y. 10011), 1971. Pp. xv + 228. Price $ 14.50.

Biochemical Responses to Environmental Stress. Edited by I. A. Bernstein. (Plenum Pub. Corpn., New York, N.Y. 10011), 1971. Pp. xii + 153. Price $ 7.95.

Advances in Experimental Medicine and Biology (Vol. 11)—*Muscle Metabolism During Exercise.* Edited by B. Pernow and B. Saltin. (Plenum Pub. Corpn., 227, West, 17th Street, New York, N.Y. 10011), 1971. Pp. xvi + 558. Price $ 22.50.

3162-71. **Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.**

COLLOQUIUM ON MICROPALAEONTOLOGY AND STRATIGRAPHY

A COLLOQUIUM on Indian micropalaeontology and stratigraphy was convened in Bangalore from October 8–10, 1971 on the occasion of celebrating the 75th birthday of Professor L. Rama Rao. It was inaugurated by Prof. L. Rama Rao. The President of Colloquium was Prof. A. K. Ghosh of the University of Calcutta.

Prof. Rao, while declaring the colloquium open, traced the history of development of micropalaeontological research and the training of specialists at the Central College in Bangalore and referred to the progress made in this branch of geology in the country. He, however, regretted that the science of micropalaeontology and stratigraphy had not received the attention it deserved in India, particularly in the universities. The potential and prospects in these fields, according to Rao, are so great in India that it should aim at overtaking the other countries in this branch of science.

Prof. A. K. Ghosh, in his presidential address, thanked Prof. Rao for being able to inaugurate the colloquium and for his inspiring address. The President made some concrete suggestions about the way micropalaeontology should be developed in the country and said that the Oil and Natural Gas Commission should play a role in stimulating and strengthening research in this field of study, especially in the university departments. He was happy that the first colloquium was held in Bangalore where the first batch of Indian micropalaeontologists and the first crop of papers in this field were produced. It was the hope of the President that the holding of such colloquia would be an annual feature of the scientific activities in the country as it is elsewhere.

The technical session which lasted for two days covered, as planned, all eras of geological time and all groups of microfossils. There were, as expected, more papers on foraminifera dealing with systematic and stratigraphic aspects. The paper by V. V. Sastri and A. K. Datta (ONGC, *Dehra Dun*) on "Recent advances in the Meso-Cenozoic biostratigraphy of India" dealt with the biozones based particularly on planktonic foraminifera. It covered all the sedimentary basins of India, including those of Andaman and Nicobar Islands. The paper provided a 'spectrum', through tables and range-charts, of the biostratigraphic zonation of the vast sequences of the entire Mesozoic and Cenozoic Eras.

The paper by M. S. Srinivasan (*Varanasi*) on "Late Neogene Epoch Boundaries in Andaman-Nicobar Islands" dealt with the planktonic foraminifera of the upper Miocene and Pliocene sections and the biostratigraphic zones based on them. A comparison of these zones with those established elsewhere for the same period (Miocene-Pliocene) was an important aspect of his contribution. The paper on "Stratigraphy and Microfauna of Car Nicobar Island, Bay of Bengal" by M. S. Srinivasan and V. Sharma gave an account of the complete stratigraphic sequence as well as the three biostratigraphic sequences based on planktonic foraminifera. Another paper on "Middle Miocene Foraminifera from Nancowry and Kamorta Islands, Bay of Bengal" by M. S. Srinivasan and S. S. Srivastava dealt with the fairly rich assemblage of smaller foraminifera belonging to zones N.10 and N.11 of the Neogene. These three papers from Varanasi provided a fair knowledge of the Neogene stratigraphy and foraminifera of Andaman and Nicobar Islands. It was interesting to note that certain sedimentary rocks in these islands had been mapped as basic igneous rocks by earlier workers and shown as such in the geological maps published by the G.S.I. and accordingly accepted by the ONGC in their reports.

Papers dealing with Paleogene foraminifera from Rajasthan were presented by Prabha Kalia (*Delhi*) and S. N. Singh (*Lucknow*). In her paper, Kalia dealt with 12 species of Buliminids from the Middle Eocene of Rajasthan of which 6 species are new. Post-Cretaceous occurrence of *Eouvigerina* Cushman in Rajasthan is an interesting item of the results given by Kalia. A new Lituolid genus from the Middle Eocene of Rajasthan was described and discussed by Singh and Kalia who proposed a standardised terminology for describing the wall structure of arenaceous foraminifera.

V. Venkatachalapathy (*Mysore*) discussed the morphology of *Ammonia beccari* from the West Coast of India with special reference to the structure of the wall. The paper by M. V. S. Gupta (*Panaji*) dealt with the distribution pattern and taxonomic aspects of planktonic foraminifera from the top layers of three core samples collected from slope region off Bombay, Two papers on Ostracoda were presented by S. P. Jain (*Chandigarh*) and M. S. Rao (*Waltair*). Jain's paper on "Ostracodes from the Bagh beds of Madhya Pradesh" dealt with a rich assemblage of species and its value in fixing the age of the beds. Rao's paper on "Recent Ostracoda from the continental shelf of East Coast of India" dealt mainly with the evolution of the environment as indicated by the fauna.

The paper by S. B. Bhatia and A. K. Mathur (*Chandigarh*) on "Some Pliocene Charophyta from the Siwaliks" was the only contribution on fossil algae. It provided an account of a rich charophytic flora from the Middle Siwalik rocks of the Himalayas and was considered as a major addition to the knowledge of the charophytic remains from India which were, until recently, from the central regions of the country only. The paper by S. S. Gowda and S. S. Kumar (*Bangalore*) on "The Microfossils from the Type Rocks of Dharwar Group" dealt with the acritarchs and their significance in the classification and correlation of the Dharwar Group of rocks in Mysore State. Implications of this discovery of microfossils in the correlation of other Precambrian rock formations of India with the Dharwar Group of rocks were also discussed. The paper by B. S. Venkatachala (ONGC, *Dehra Dun*) with the title, "Palynological studies in the ONGC—A Review" covered different aspects of the research applied in the exploration for oil and natural gas by the Commission.

In the *Review Session,* the following participants representing different centres reviewed the work going on in their respective centres: Prof. B. S. Tewari (*Chandigarh*), Dr. P. Kalia (*Delhi*), P. P. Kumar (ONGC, *Dehra Dun*), Dr. S. N. Singh (*Lucknow*), Dr. M. S. Srinivasan (*Varanasi*), Sri M. V. A. Sastry (GSI, *Calcutta*), Dr. M. S. Rao (*Waltair*), Dr. V. Ragothamman (*Madras*), Dr. S. S. Gowda (*Bangalore*) and Dr. V. Venkatachalapathi (*Mysore*).

On the third day, the field excursion to the Archaean fossil localities near Chitradurg was not such a success as was anticipated because of very bad weather. However, a visit to the Ingaldal Mines of the Chitradurga Copper Company was a great reward to the participants, thanks to the authorities of the Company.

Dept. of Geology, S. Sambe Gowda.
Bangalore University,
Central College, Bangalore.

CHEMICAL TREATMENT, PRESERVATION AND ANALYTICAL STUDY OF PAUNAR COINS

K. T. M. HEGDE

Department of Archaeology and Ancient History, The M.S. University of Baroda, Baroda-2

PAUNAR (20° 47′ N, 78° 42′ E) is today a small village in Wardha Taluk of Wardha District in Maharashtra State. Recent excavation in the village has shown that it is a place of much antiquity[1]. In 1965 when the foundation of Village Panchayat School was being laid, a beautiful, globular, spouted copper vessel with a fitting lid came to light (Fig. 1). It was found to contain a hoard of coins. Professor S. B. Deo, Head of the Department of Ancient History, Culture and Archaeology, Nagpur University, identified the coins as Vishnukundin coins.

Professor Deo brought these coins, 310 in all, to the Department of Archaeology and Ancient History, M.S. University of Baroda, for their chemical treatment and preservation. When it was suggested that an analytical study in a few coins might reveal interesting data on

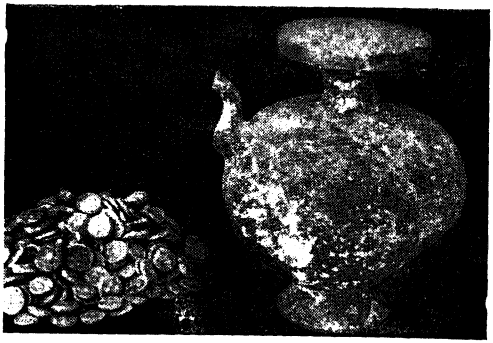


FIG. 1. Globular, spouted copper vessel beside the hoard of Vishnukundin coins which it contained. Coins are covered with corrosion incrustation.

them, he very kindly permitted us to choose five coins. The analytical study revealed two hitherto unknown coinage alloys of the past, and an altogether new technique in minting.

The coins were thinly covered with greenish corrosion compounds. In corrosion cover they looked like corroded copper coins. In most of the coins the die struck legends and designs were discernible in spite of the corrosion. Figure 1 illustrates the coins in corroded condition.

The surface of the coins was found to be covered with macro and micro cracks. The metal of the coins was brittle. An analytical study in the corrosion incrustation of the coins revealed copper, iron and tin compounds in 218 coins and copper and iron compounds in rest of the coins. Three coins from the former group and two from the latter group were selected for quantitative chemical analysis discussed below. The fifth coin selected for analysis revealed an iron core while a sample piece was cut from it.

CHEMICAL TREATMENT AND PRESERVATION OF COINS

The following process was used to remove the corrosion incrustation on the coins. First, the coins were suspended in warm 10% solution of alkaline Rochelle salt which dissolved the cupric incrustation. The cuprous incrustation was then oxidised to cupric state in warm hydrogen peroxide solution and dissolved in alkaline Rochelle salt solution. Next, the coins were suspended among zinc granules covered with 5% solution of warm sodium hydroxide, where evolved nascent hydrogen reduced the incrustation. Finally, the electrolytic reduction of the incrustation was carried out in an electrolytic bath of 2% solution of sodium hydroxide. Coins were made cathode. Pure iron rod was used as anode. Hydrogen evolved at the cathode further reduced the inscrustation.

When the incrustation was removed, each coin was washed in hot and cold distilled water, dried in desiccator over silica gel and preserved with a coat of 2% solution of polyvinylacetate. Figure 2 shows a representative collection of the coins after their chemical treatment and preservation.

ANALAYTICAL STUDY OF THE COINS

A quantitative chemical analysis of the five coins yielded the following results :

Sr. No. of coins	Cu	Fe	Sn	Pl	Zn	Ag	Al	Mn	Co	Ni	As	Bi	Sb	Undetermined	Total
1	74·60	21·76	3·20	0·30	tr	..	tr	..	tr	tr	..	tr	..	0·14	100
2	73·77	22· 0	3·35	0·37	tr	.	tr	..	tr	tr	..	tr	..	0·11	100
3	71·91	23·21	4·41	0·24	tr	..	tr	..	tr	tr	..	tr	..	0·23	100
4	77·31	22·10	..	0·42	tr	..	tr	tr	tr	tr	..	tr	..	0·17	100
5	77·21	22·31	..	0·26	tr	..	tr	tr	tr	tr	.	tr	..	0·22	100

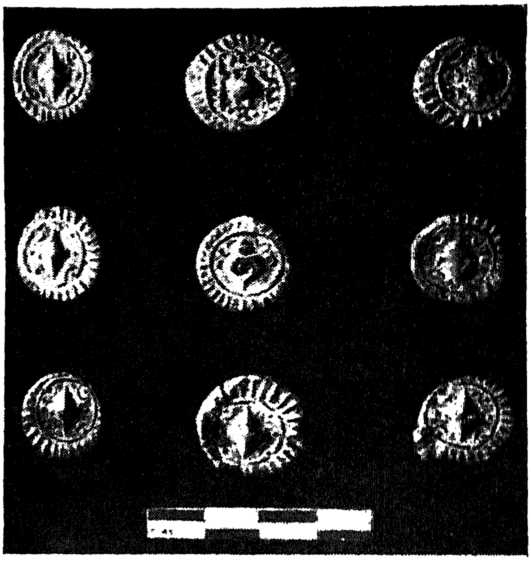


FIG. 2. The Vishnukundin coins after chemical treatment and preservation.

The above results indicate that coin Nos. 1, 2 and 3 were struck from ternary alloys consisting of copper, iron and tin. Coin No. 4 was made of a binary alloy consisting of copper and iron. Coin No. 5 contained an iron core. Its cover, as shown above, was made up of a binary alloy consisting of copper and iron. Further, it is possible to observe that in coin Nos. 1, 2 and 3, iron was alloyed with low tin bronze. In coin Nos. 4 and 5 iron was alloyed with copper. In view of the fact that all the five selected coins indicated substantial quantities of iron in them, the rest of the 305 coins were tested with magnet. The test proved that iron was present in all of them. These observations are not without significance.

While coins of copper-tin alloy and copper-tin-silver alloy are known, fusion of iron either in bronze or in copper, or the use of iron core for the purpose of minting coins has not been so far recorded. Paunar coins are the first to reveal these alloys and the iron core in ancient coinage.

Author's thanks are due to Professor R. N. Mehta for valuable discussion and to Professor S. B. Deo for bringing the coins to Baroda and giving permission to cut five coins for analysis and for his valuable comments.

1. Deo, S. B., and Dhavalikar, M. K., *Paunar Excavation*, Nagpur, 1968.

VIBRATIONAL SPECTRA AND NORMAL VIBRATIONS OF N-METHYLTHIOACETAMIDE

K. VENKATA RAMIAH AND SHYAMALA KRISHNA SAYEE
Department of Physics, Osmania University Post-Graduate Centre, Warangal (A.P.)

INTRODUCTION

SPECTROSCOPIC studies of primary, secondary and tertiary amides received considerable attention. Studies of intermolecular associations[1], dichronic absorption studies[2], band contour studies of the vapour spectra[3], measurement of integrated intensities of the absorption bands arising out of the stretching vibrations of the C=O and N–H groups[4,5] and normal co-ordinate analysis[6-10] gave information regarding the nature of the functional groups, orbital interactions and mixing of the skeletal frequencies arising out of the inplane modes of vibration.

In recent times, spectra of some primary, secondray and tertiary thioamides[11,6,10] have been recorded and normal co-ordinate treatment of some of these molecules has been carried out to assign the C–N and the C=S stretching frequencies and estimate the magnitude of the coupling between these modes of vibration and to compare these results with those obtained of C–N and C=O stretching modes in the corresponding amides[7].

EXPERIMENTAL AND NORMAL CO-ORDINATE TREATMENT

The authors have recorded the infrared spectra of N-methylthioacetamide and its N-deuterated species and have carried out the normal co-ordinate treatment in order to clarify the nature of the absorption bands arising out of the inplane modes of vibration and compare these results with those of N-methylacetamide obtained by the earlier workers. The frequencies of the functional groups of the N-methylthioacetamide and N-deuterated N-methylthioacetamide are given in Table I.

TABLE I

N-Methylthioacetamide		N-Deuterated N-methylthioacetamide	
Mode of vibration	Frequency	Mode of vibration	Frequency
ν (N–H) ..	3283	ν (N–D) ..	2380
Amide II Band	1560	Amide II Band	1510
,, III ,,	1360	,, III ,,	1260
ν (C=S) ..	690	ν (C=S) ..	680
δ (N–H) $\perp$ ..	740	δ (N–D) $\perp$ ..	515

The corresponding frequencies of N-methylacetamide and N-deuterated N-methylacetamide obtained by the earlier workers[12] are given in Table II for comparison.

TABLE II

N-Methylacetamide		N-Deuterated N-methylacetamide	
Mode of vibration	Frequency	Mode of vibration	Frequency
ν (N–H) ..	3330	ν (N–D) ..	2475
Amide II Band	1558	Amide II Band	1479
,, III ,,	1300	,, III ,,	1120
ν (C=O) ..	1647	ν (C=O) ..	1639
δ (N–H) $\perp$ ..	705	δ (N–D) $\perp$ ..	520

The frequency of the amide III band in N-methylthioacetamide is at 1360 cm^{-1} while the corresponding absorption in N-methylacetamide occurs at 1300 cm^{-1}, but the same absorption occurs at 1260 cm^{-1} in N-deuterated N-methylthioacetamide and at 1120 cm^{-1} in N-deuterated N-methylacetamide. On the other hand, the amide II, absorption occurs almost at the same frequency both in N-methylthioacetamide and N-methylacetamide, but at different frequencies in their deuterated species. It is also important to mention that the ν (N–H) and ν (N–D) frequencies in N-methylthioacetamide have lower values compared to those of the corresponding frequencies in N-methylacetamide.

N-methylthioacetamide is treated as a six-body problem taking CH_3 group as a point mass. The structure of N-methylthioacetamide is shown is Fig. 1.

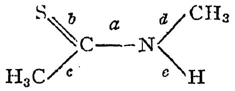


FIG. 1

The molecule belongs to the point group Cs and the twelve fundamentals which are classified as nine inplane (A′) and three out of plane (A″) vibrations are active both in the infrared and Raman spectra. The orthonormalised set of symmetry co-ordinates for the inplane vibrations of the molecule is given in Table III.

TABLE III

Symmetry co-ordinates	Vibrational mode
$R_1 = \triangle a$	ν (C–N)
$R_2 = \triangle b$	ν (C=S)
$R_3 = \triangle c$	ν ($C-CH_3$)
$R_4 = \triangle d$	ν ($N-CH_3$)
$R_5 = \triangle e$	ν (N–H)
$R_6 = 1/\sqrt{6}\ (2\triangle ab - \triangle ca - \triangle bc)$	δ (S=C–N)
$R_7 = 1/\sqrt{2}\ (\triangle bc - \triangle ac)$	γ ($C-CH_3$)
$R_8 = 1/\sqrt{6}\ (2\triangle ad - \triangle de - \triangle ae)$	δ ($N-CH_3$)
$R_9 = 1/\sqrt{2}\ (\triangle ae - \triangle ed)$	δ (N–H)

The expressions for the elements of the F and the G matrices are obtained in the usual way and the structure parameters used in these computations are : γ (C=S) = 1·713 Å, γ (C–N) = 1·29 Å, γ (N–H) = 1·07 Å, and γ ($C-CH_3$) = 1·55 Å. All the bond angles are assumed as 120°. General quadratic potential function is the force field used in these calculations.

The secular determinant which has the dimensionality of 9 × 9 has been solved by the modified Danielewsky's method using a programme written in Fortran language for Model 2, IBM 1620 digital computer. General programme of IBM 1620 was used to extract the roots of the polynominal.

The force constants proposed in related molecules were transferred and they were varied to obtain a close fit between the observed and calculated frequencies. The final set of force constants used in these calculations are given in Table IV. The observed, calculated frequencies and the potential energy distribution of each normal mode among various symmetry co-ordinates as obtained in these computations are given in Table V. Similar results obtained by Miyazawa *et al.*[7] in case of N-methylacetamide are given in Table VI for comparison.

TABLE IV

Force constants

$f_a = 7$	$f_{ae} = 0\cdot3$
$f_b = 4$	$f_{ad} = 1\cdot8$
$f_c = 4\cdot3$	$f_a^b = 0\cdot32$
$f_d = 5$	$f_b^c = 1\cdot2$
$f_e = 6$	$f_a^c = 1\cdot2$
$f_{ab} = 0\cdot34$	$f_c^{bc} = 0\cdot9$
$f_{bc} = 0\cdot9$	$f_c^{ca} = 0\cdot6$
$f_{ca} = 0\cdot8$	

Bond stretching and bond-bond interaction constants are in md/A, bond-angle interaction constants are in md/γad and bond-bending constants are in md A/γad².

Although the N–H stretching frequency is high compared to the remaining skeletal

TABLE V

Potential energy distribution of different modes of vibration among various symmetry co-ordinates of N-methylthioacetamide

Mode of vibration	Frequencies (cm^{-1})		Potential energy distribution								
	Observed	Calculated	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9
Amide III	1360	1315	21	14	2	0	0	1	10	6	43
ν (C=S)	690	709	16	61	7	4	0	2	4	2	2
ν ($C-CH_3$)	950	941	3	0	75	13	0	0	0	11	0
ν ($N-CH_3$)	1100	1120	4	0	1	60	0	3	1	22	21
ν (N–H)	3283	3300	0	0	0	0	99	0	0	0	0
δ (S=C–N)	..	176	5	0	2	0	0	85	0	14	0
γ ($C-CH_3$)	370	350	0	17	0	4	0	0	77	0	0
δ ($N-CH_3$)	555	582	2	7	11	10	0	7	5	53	1
Amide II	1547	1557	46	3	1	10	0	0	2	2	36

TABLE VI

Potential energy distribution of different modes of vibration among various symmetry co-ordinates of N-methylacetamide

Mode of vibration	Frequencies (cm^{-1})		Potential energy distribution							
	Observed	Calculated	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8
Amide III	1299	1296	35	9	22	1	12	1	0	29
ν (C=O)	1653	1644	10	78	4	0	3	6	3	9
ν (C–CH_3)	881	954	11	11	37	0	18	0	11	0
ν (N-CH_3)	1096	1006	1	1	7	78	1	4	5	1
δ (O=C-N)	627	602	1	1	28	7	42	9	9	0
γ (C-CH_3)	436	436	5	2	1	8	0	74	6	1
δ (N-CH_3)	289	279	0	0	0	0	26	7	67	0
Amide II	1567	1509	44	3	3	6	4	1	0	63

frequencies, it has been taken by the authors into consideration for the normal co-ordinate treatment. On the other hand, it has been separated out from the other frequencies by Miyazawa *et al.* in case of N-methylacetamide.

DISCUSSION OF THE NATURE OF THE ABSORPTION BANDS

The amide II and the amide III absorption bands in N-methylthioacetamide which are in the region of 1547 cm^{-1} and 1360 cm^{-1} arise out of the combined contribution of δ (N–H) and ν (C–N) vibrations. This result is similar to that of N-methylacetamide as indicated by the potential energy distribution given in Tables V and VI. It is significant to note that in the case of N-methylthioacetamide to the absorption at 1547 cm^{-1}, the contribution of ν (C–N) is higher than that of N–H deformation. Similarly to the frequency at 1360 cm^{-1}, the contribution of δ (N–H) is considerably higher than that of ν (C–N) vibration. These results are different from those obtained by Miyazawa *et al.* in the case of N-methylacetamide. In this case, to the amide II bands the contribution of δ (N–H) is more than that of ν (C–N) and to the amide III band, the contribution of ν (C–N) is higher than that of δ (N–H). This may explain the smaller variation in the frequencies of the amide II and the amide III absorption bands on deuteration of N-methylthioacetamide.

The band at 690 cm^{-1} is due to ν (C=S) and the contribution of the amide III frequency to this absorption is considerable. Similar result has been obtained by Miyazawa *et al.* in case of ν (C=O) and the amide III absorption frequencies as seen from the potential energy distribution given in Table VI.

The bands at 950 cm^{-1} and 1100 cm^{-1} are assigned to C–CH_3 and N–CH_3 stretching vibrations respectively and there is almost no coupling between these two modes of vibration. The absorption at 3300 cm^{-1} is due to the N–H stretching vibration and it is significant to note that there is no contribution of any other mode of vibration to this frequency.

The frequency at 176 cm^{-1} is due to the δ (S=C–N) vibration and this result is in agreement with that obtained by earlier workers in the case of tertiary thioamides[10]. The bands at 555 cm^{-1} and 370 cm^{-1} are assigned to δ (N–CH_3) and γ (C–CH_3) vibrations respectively. γ (C–CH_3) and ν (N–CH_3) are contributing to the δ (N–CH_3) vibration while to the γ (C–CH_3), the contribution of the C=S stretching vibration is considerable. On the other hand, in case of N-methylacetamide, δ (O=C–N) makes substantial contribution to δ (N–CH_3). Similarly ν (N–CH_3) contributes to γ (C–CH_3) vibration. This may explain the considerable difference in the values of the frequencies of δ (N–CH_3) and γ (C–CH_3) vibrations in N-methylthioacetamde and N-methylacetamide.

---

1. Puranik P. G. and Venkata Ramiah, K., *J. Mol. Spectry.*, 1959, **3**, **486**.
2. Soichi Hayachi. *J. Chem. Soc. Japan*, 1965, **86**, 27. *Ibid.*, 1965, **86**, **790**
3. Lumley Jones, R , *J. Mol. Spectry.*, 1963, **11**, 411.
4. Venkata Chalapathi. V. and Venkata Ramiah, K., *Ibid.*, 1968, **26**, **444**.
5. Usha Bai, P. and Venkata Ramiah, K., *Bull. Chem. Soc. Japan*, 1971, **44** 373.
6. Suzuki, I., *Ibid.*, 1962, **35**, 1456
7. Miyazawa. T., Mizushima. S. and Shimanouchi, T., *J. Chem. Phys.*, 1958, **29**, 611.
8. Venkata Chalapathi, V. and Venkata Ramiah, K., *Proc. Ind. Acad. Sci.*, 1968, **68**, 109.
9. Suzuki, I., *Bull Chem. Soc. Japan*, 1962, 35, **1449.**
10. Indirachary, C. A. and Venkata Ramiah, K., *Proc. Ind. Acad. Sci.*, 1969, **69**, 18.
11. Suzuki, I.. *Bull. Chem. Soc. Japan*, 1962, **35**, 1286.
12. Venkata Chalapathi. V. and Venkata Ramiah, K., *Proc. Ind. Acad, Sci.*, 1968, **67**, 184.

BASE HYDROLYSIS AND AQUATION OF *TRANS*-CHLOROPYRIDINEBISDIMETHYLGLYOXIMATOCOBALT (III)

V. R. VIJAYARAGHAVAN AND M. SANTAPPA
Department of Physical Chemistry, University of Madras, Madras-25

KINETIC studies of aquation and base hydrolysis of complexes of the type acidoaminebisdimethylglyoximecobalt (III) [Co $(DH)_2$ AmX] (Am = aromatic or aliphatic amine, X = univalent anion and DH = dimethylglyoxime)[1-4] are few. These complexes are an interesting contrast to their bisethylenediamine analogues in that they are neutral while the latter are positively charged. We report here our results on the kinetics of base and acid hydrolyses of *trans*-chloropyridinebisdimethylglyoximatocobalt (III), [Co $(DH)_2$ (py) (Cl)]; (py = pyridine).

The complex was prepared by the method of Ablov and Samus[5]. Aqueous alcohol was used for all the experiments as solvent.

The kinetics of acid hydrolysis was studied by titrating potentiometrically 10 ml aliquots of complex solution to which 2 ml of 0·2 M HNO_3 and 10 ml of acetone at 0° C was added, against standard (0·002 M) silver nitrate using silver and calomel electrodes. In base hydrolysis, the aliquots were transferred into stoppered tubes containing 2 ml of 0·2 M HNO_3 and the chloride estimated potentiometrically. Spectrophotometric measurements for equilibrium studies were carried out in a Hilger-Watts Uvispek H 700 spectrophotometer.

It has been shown[6] that in the case of *trans*-acidoamine or diacidobisdimethylglyoximatocobalt (III) complexes, the *trans*-stereochemistry is retained during substitution reactions.

On the addition of alkali, a change in colour from yellowish-brown to reddish-brown was observed, attributable to a rapid and reversible deprotonation reaction:

$$[\mathrm{Co\,(DH)_2\,(py)\,(Cl)}] + \mathrm{OH^-} \overset{K}{\rightleftharpoons} [\mathrm{Co\,(D_2H)\,(py)\,(Cl)}]^- + \mathrm{H_2O} \qquad (1)$$

The equilibrium constant K was determined spectrophotometrically from the slope and intercept of the linear plot of $[(A/[Co]_{tot}) - \epsilon_{DH^-}]^{-1}$ *vs.* $[OH^-]_{eq}$ according to equation[7] (2):

$$[(\mathbf{A}/[\mathrm{Co}]_{tot}) - \epsilon_{DH}]^{-1} = (\epsilon_D - \epsilon_{DH})^{-1}\,(1 + K^{-1}\,[\mathrm{OH^-}]_{eq}{}^{-1}) \qquad (2)$$

where

A is the absorbance of the complex solution,

ϵ_D and ϵ_{DH} are the measured extinction coefficients of [CO (D_2H) (py) (Cl)]$^-$ and [Co $(DH)_2$ (py) (Cl)] respectively,

$[Co]_{tot}$ = [Co $(DH)_2$ (py) (Cl)] + [Co (D_2H) (py) (Cl)]

and $[OH^-]_{eq} = [OH^-]_{tot} - [CB]$.

(CB = conjugate base, [Co (D_2H) (py) (Cl)]$^-$, equal to the concentration of OH^- consumed for deprotonation.)

[CB] was computed from the experimentally determined extinction coefficients of the two species [Co $(DH)_2$ (py) (Cl)] and [Co (D_2H) (py) (Cl)]$^-$ at two wavelengths, *viz.*, λ = 400 and 440 mμ. The value of K obtained at 30° C was 1545 M^{-1}.

In base hydrolysis studies, the concentration of OH^- was varied from 0·001 M to 0·03 M and was always in excess of the complex concentration. Psuedo-first order rate constants for the appearance of Cl^- were obtained (Table I).

TABLE I

Pseudo-first order rate constants for base hydrolysis of [Co $(DH)_2$ (py) (Cl)]; [complex] = 8·66 × 10^{-4} M; [EtOH] = 10% (v/v); T = 30° C; μ = 0·1 M. ($NaClO_4$)

$[OH^-]_{eq} \cdot 10^4$ M.	..	9·78	14·03	21·81	42·48
$k_{obs} \cdot 10^4$ sec^{-1}	..	2·07	2·43	3·07	3·31
$[OH^-]_{eq} \cdot 10^4$ M	..	91·77	121·77	191·53	291·41
$k_{obs} \cdot 10^4$ sec^{-1}	..	3·68	3·92	4·55	5·68

A plot of k_{obs} *vs.* $[OH^-]_{eq}$ was a curve, indicating a pre-equilibrium step. On the other hand, a plot of $k^{-1}{}_{obs}$ *vs.* $[OH^-]^{-1}{}_{c}$ was linear for $[OH^-]_{eq}$ = 9·78 × 10^{-4} to 91·77 × 10^{-4} M.

The experimental results may be explained by the following mechanism known as S_N1 CB, up to pH 12:

$$[Co(DH)_2(py)(Cl)] + OH^- \overset{K}{\rightleftharpoons} [Co(D_2H)(py)(Cl)]^- + H_2O \quad (i)$$

$$[Co(D_2H)(py)(Cl)]^- \xrightarrow{k_b} [Co(D_2H)(py)] + Cl^- \quad (ii)$$

$$[Co(D_2H)(py)] + H_2O \xrightarrow{\text{fast}} [Co(DH)_2(py)(OH_2)] \quad (iii)$$

An S_N2CB mechanism according to which both OH^- and Cl^- are weakly bound simultaneously to the metal in the transition state cannot be ruled out.

The above equations (*i*) to (*iii*) would lead to

$$k_{obs.} = k_b K [OH^-]_{eq}/(1 + K[OH]_{eq}) \quad (3)$$

where k_b is the rate constant due to the conjugate base formed in the pre-equilibrium step (*i*). $k_b = 3{\cdot}85 \times 10^{-4}$ sec^{-1} and $K = 1277$ M^{-1} were obtained from the slope and intercept of the plot of k^{-1}_{obs} *vs.* $[OH^-]^{-1}$. A fairly good agreement with $K = 1545$ M^{-1} obtained from spectrophotometric studies was obvious.

Since the plot of k^{-1}_{obs} *vs.* $[OH^-]^{-1}_{eq}$ deviated from linearity for $[OH^-]_{eq} > 91{\cdot}8 \times 10^{-4}$ M and the plot of k^{-1}_{obs} *vs.* $[OH^-]^{-2}$ was linear, it was concluded that under these conditions of pH > 12, the following mechanism may be operative:

$$[Co(DH)_2(py)(Cl)] + OH^- \overset{K}{\rightleftharpoons} [Co(D_2H)(py)(Cl)]^- + H_2O \quad (iv)$$

$$[Co(D_2H)(py)(Cl)]^- + OH^- \xrightarrow{\text{fast}} [Co(D_2H)(Cl)(OH)]^{2-} + py \quad (v)$$

$$[Co(D_2H)(Cl)(OH)]^{2-} \xrightarrow{k_c} [Co(D_2H)(OH)]^- + Cl^- \quad (vi)$$

$$[Co(D_2H)(OH)]^- + H_2O \xrightarrow{\text{fast}} [Co(DH)_2(OH)_2]^- \quad (vii)$$

These equations lead to

$$k_{obs.} = \frac{k_c K [OH^-]^2}{1 + K[OH^-]}. \quad (4)$$

For $10 < \text{pH} < 13$ equation (5), *i.e.*, combination of equations (3) and (4) would be applicable:

$$k_{hyd.} = \frac{k_b K [OH^-] + k_c K [OH^-]^2}{1 + K[OH^-]}. \quad (5)$$

From the linear plot of k_{hyd} $(1 + K[OH^-])$ $[OH^-]^{-1}$ *vs.* $[OH^-]$, slope $(k_c K) = 15{\cdot}28$ and hence $k_c = 9{\cdot}88 \times 10^{-3}$ M^{-1} sec^{-1}, intercept K) $= 0{\cdot}46$ and hence k ($k_b = 3{\cdot}8 \times 10^{-4}$ sec^{-1} (for $K = 1277$) or $k_b = 3{\cdot}0 \times 10^{-4}$ sec^{-1} (for $K = 1545$) were obtained.

The rate constants for acid hydrolysis in 0·01 M $HClO_4$ and 0·1 M ionic strength are shown in Table II.

TABLE II

Rate constants for acid hydrolysis *[EtOH] = 10%. (v/v)*

T° C	..	30	35	40
$k.10^5$ sec^{-1}	..	2·69	5·74	11·40

The activation parameters are $E = 27{\cdot}14$ k. cal. mole^{-1}, log $A = 15$ and $\Delta S^{\ddagger} = 10{\cdot}06$ e.u. The value of E is in the general range of activation energies for aquation of Co (III) complexes.

---

1. Basolo, F. and Pearson, R. G., *Mechanisms of Inorganic Reactions*, Chapter 3, John Wiley & Sons., New York, 1967.
2. Costa, G., Tauzher, G. and Puxeddu, A., *Inorganica Chimica Acta*, 1969, **3**, 41.
3. Chan, S. C. and Leung, P. Y., *Aust. J. Chem.*, 1969, **22**, 2569.
4. Hague, D. N. and Halpern, J., *Inorg. Chem.*, 1967, **4**, 2059.
5. Ablov, A. V. and Samus, I. D., Russ., *J. Inorg. Chem.*, 1959, p. 1004.
6. —, *Dokl. Akad. Nauk. SSSR*, 1954, **97**, 1019.
7. Brik. J. P., Chock, P. B. and Halpern, J., *J. Am. Chem. Soc.*, 1968, **90**, 6959.

LETTERS TO THE EDITOR

CRYSTAL DATA OF AN AMMONIUM SALT OF CYCLIC CYTIDINE-2′, 3′-PHOSPHATE

THE cyclic-2′, 3′-phosphate esters occur as intermediates in the breakdown of RNA. The cyclic cytidine-2′, 3′-phosphate is also important as a substrate for the ribonuclease. We have now crystallized an ammonium salt of this nucleotide by slow diffusion of acetone into water solutions of the compound. The material precipitated mostly as powder, except in one crop which yielded four needle shaped crystals after a period of about five weeks.

Paper chromatography by descending technique was carried out on Whatman No. 1 paper, using the solvent isopropyl alcohol, conc. ammonia and water (7 : 1 : 2). From R_f values of cyclic cytidine-2′, 3′-phosphate ($R_f = 0{\cdot}375$) and cytidine 2′(3′) phosphate (mixed isomers, $R_f = 0{\cdot}118$) it was confirmed that the crystal was cyclic cytidine-2′, 3′-phosphate.

Rotation, Weissenberg and Precession photographs were taken using Cu K_α radiation. The crystals belong to monoclinic system with the space group $P2_1$. The complete crystal data are given in Table I.

TABLE I

Crystal data of cyclic cytidine 2′, 3′-phosphate

Formula	$C_9H_{11}N_3O_7P.NH_4^+$
M.W.	322·2
System	Monoclinic
a	$9{\cdot}74 \pm 0{\cdot}02$ Å
b	$8{\cdot}89 \pm 0{\cdot}02$ Å
c	$7{\cdot}24 \pm 0{\cdot}01$ Å
β	98°
V	620·9 Å^3
Z	2
$d_{\text{calc.}}$	$1{\cdot}723$ gm. cm^{-3}
μ(Cu K_α)	$24{\cdot}13$ cm^{-1}
Systematic absences	$0k0$ k-odd
Space group	$P2_1$

The authors thank Dr. T. M. Jacob and Mr. A. S. Gopalakrishnan of Biochemistry Department of this Institute, for kindly supplying the material used in this study and for performing the paper chromatography test. They also thank Prof. P. S. Narayanan for his interest in this work.

Dept. of Physics,
Indian Institute of Science,
Bangalore-12, *October* 13, 1971.

B. SWAMINATHA REDDY.
M. A. VISWAMITRA.

FRANCK-CONDON FACTORS AND r-CENTROIDS FOR THE A-X SYSTEM OF THE SiH$^+$ MOLECULE

IT is probable that the spectrum of SiH$^+$ appears in sources of astrophysical importance[1]. In view of the interest in SiH Franck-Condon factors and r-centroids for the $A^1\pi$–$X^1\Sigma^+$ band system of this molecule have been reported in the present note.

The method of α-averaging proposed by Fraser and Jarmain[2] and the computational technique described by Sankaranarayanan[3] have been applied for the evaluation of Franck-Condon factors. Since for this system $\delta a/a < 5\%$, no r_e-shift correction has been applied. The r-centroids have been calculated by quadratic equation method suggested by Nicholls and Jarmain[4]. The results have been presented in Table I. The basic molecular constants have been taken from the work of Douglas and Lutz[1]. The calculated values of Franck-Condon factors are in good agreement with the observed visual intensities. As $re_1 > re_2$, the r-centroids show the expected increase with decrease in wavenumber.

TABLE I

v'' v'		0	1	2	3	4
	(*a*)	0·1972	0·1792	0·1061	0·0628	0·0441
0	(*b*)	1·6395	1·7507	1·8441	1·9301	2·0128
	(*c*)	25025·20	22936·52	20916·31	..	..
	(*a*)	0·1424	0·1288	0·0589	0·0091	0·0032
1	(*b*)	1·6143	1·7313	1·8262	1·9127	1·9952
	(*c*)	25415·38	23326·68	..	..	..
	(*a*)	0·1071	0·0331	0·0030	0·0136	0·0501
2	(*b*)	1·5916	1·7151	1·8115	1·8984	1·9809
	(*c*)	..	..	..	..	..
	(*a*)	0·1200	0·0043	0·0027	0·0320	0·0308
3	(*b*)	1·5721	1·7022	1·8001	1·8874	1·9698
	(*c*)	..	..	..	..	..
	(*a*)	0·0738	0·0009	0·0278	0·0014	0·0606
4	(*b*)	1·5568	1·6930	1·7920	1·8796	1·9621
	(*c*)	..	..	..	..	..

(*a*) Frank-Condon factors, (*b*) r-Centroids, (*c*) Wavenumbers.

The authors are thankful to Prof. D. Sharma and Dr. R. C. Maheshwari for helpful discussions.

Physics Department, I. D. Singh.
University of Gorakhpur, M. Prasad.*
Gorakhupr, India, September 3, 1971.

---

* Present Address: Department of Physics, St. Andrews College, Gorakhpur.

1. Douglas, A. E. and Lutz, B. L., *Can. J. Phys.*, 1970, **48**, 247.
2. Fraser, P. A. and Jarman, W. R., *Proc. Phys. Soc.*, 1953, **66 A**, 1145.
3. Sankaranarayanan, S., *Physica*. 1963, **29**, 1403.
4. Nicholls, R. W. and Jarmain, W. R., *Proc. Phys. Soc.*, 1956, **69 A**, 253.

THE LASER-EXCITED RAMAN SPECTRUM OF *CLOSTRIDIUM PASTEURIANUM* FERREDOXIN

Because they would absorb the incident visible light, the study of coloured transparent biological molecules by Raman scattering has not been possible previously. However, Laser-Raman spectroscopy makes the study possible if the molecules do not absorb in the 6328 Å region. Several spectroscopic techniques like Electron Spin Resonance, Mössbauer and Optical Absorptino have been used to study these iron-sulphur proteins[1-4]. But Raman scattering has not been applied so far.

The Raman spectra were recorded by using Spectra-physics 125 He-Ne Laser giving intense beam at 6328 Å and 50 mW power and Coderg recording spectrophotometer. The horizontally and vertically polarized spectra were recorded by using a quarta wave plate in the path of the beam. The use of interference filters in the path of the incident beam eliminated source lines other than the 6328 Å line.

The ferredoxin sample was first reduced with sodium hydrosulphite and then reoxidized by shaking in air.

The unreduced sample of *Clostridium pasteurianum* ferredoxin does not show any Raman lines. On addition of excess sodium hydrosulphite, three Raman lines at 145, 430 and 610 cm^{-1} are seen as shown in Fig. 1. All these

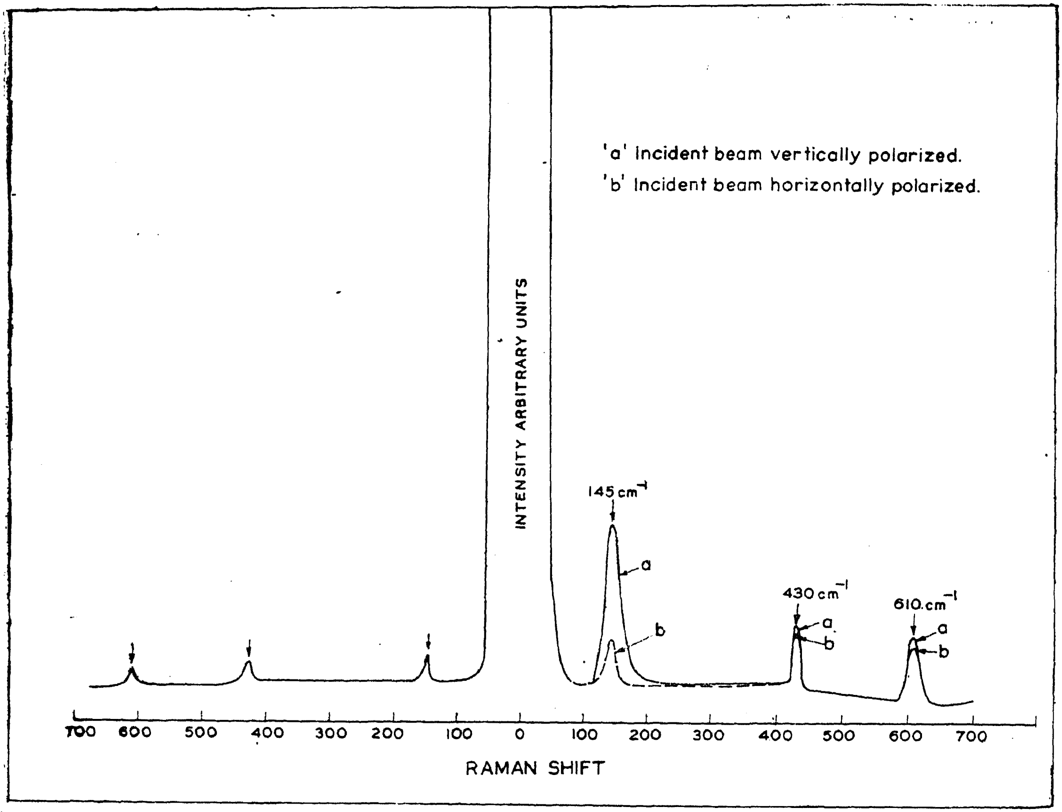


FIG. 1. The laser-excited Raman Spectrum of *Closteridium pasteurianum*. To 0·17 mg/ml protein in 0·1 M phosphate buffer of pH 7·2 a small amount of sodium hydrosulphite was added and spectrum taken after five minutes.

lines show their antistokes component as well. The lines disappear on shaking the protein in air (reoxidation). No previous data on the Raman spectra of such proteins or proteins in general have appeared before, nor can the author at present throw light on the nature of the bonds responsible for the Raman lines. The lines appear to originate in or very near the bonds of $Fe-S^{=}$ center of the ferredoxin which undergoes oxidation and reduction and indicates conformational change in the active center on reduction. Buchanan, Lovenberg and Rabinowitz[2,3] have compared the infra-red spectra of dry clostridial ferredoxin with its apoprotein and found both to show similar lines. This would indicate that the oxidisable and reducible bonds of ferredoxin were not represented in their i.r. spectra.

Further work is in progress to study the nature of the observed Raman lines. The application of this spectroscopic technique might prove useful in studying the conformational changes in other iron-sulphur proteins, particularly the Nitrogenases (Fractions I and II) which are involved in the fixation of atmospheric nitrogen.

The purified protein was a generous gift from Professors W. H. Orme-Johnson and H. Beinert. The author expresses his thanks to Dr. S. Radhakrishna, Department of Physics, I.I.T., New Delhi-29, for his help in recording the Raman Spectrum.

Microbiology and Y. I. Shethna.
Pharmacology Laboratory,
Indian Institute of Science,
Bangalore-12, *October* 8, 1971.

---

1. Mortensen, L. E., Valentine, R. C. and Carnahan, J. E., *Biochem. Biophys. Res Communs.*, 1962, **7**, 448.
2. Buchanan, B. B., Lovenberg, W. and Rabinowitz, J. C., *Proc. Natl. Acad. Sci. U.S.*, 1963, **49**, 345,
3. Lovenberg, W. Buchanan, B. B. and Rabinowitz. J. C., *J. Biol. Chem.*, 1963, **238**, 3899.
4. Orme-Johnson, W. H and Helmut Beinert, *Biochem. Biophys. Res. Communs.*, 1969, **26**, 337.

EXTRAPOLATION METHOD FOR THE DETERMINATION OF AVERAGE GRAIN-SIZE OF POLYCRYSTALLINE MATERIALS BY X-RAY DIFFRACTION

The methods of determining the average grain size of polycrystalline materials from spotty X-ray diffraction rings were attempted by (1) Rooksby[1]—Visual method. (2) Stephan and Barnes[2] and Krishna Rao and Gopala Krishna[3]—Spot counting method, and (3) Clark and Zimmer[4] and Gopala Krishna and Ramchander[5]—Spot dimension method.

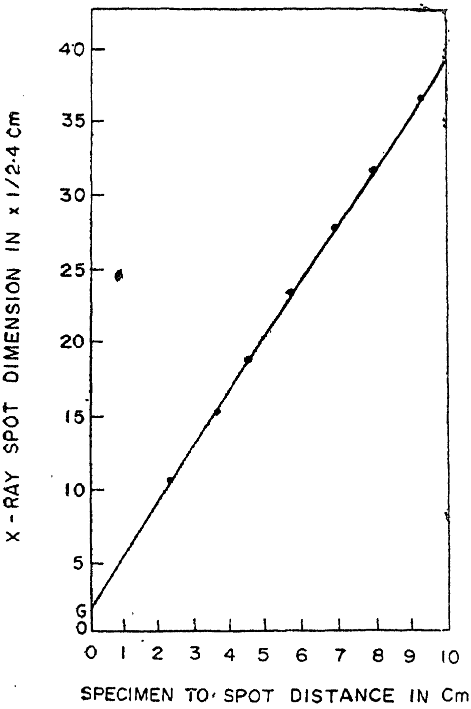


Fig. 1. Variation of the spot dimension with the specimen to spot distance. The intercept OG = 56 microns. Actual size = 53 microns.

All the above three methods involve calibration and hence require a set of experimental conditions. As a result for assessing the average grain size of a given sample the experiment has to be performed under the same experimental conditions. The calibration in the case of spot counting and spot dimension methods involves the determination of the divergence of the X-ray beam also. The extension of the counting method to crystalline mixtures for determining the average grain size of the constituents and the difficulties involved have been pointed out by Gopala Krishna and Ramchander[5] in their attempt to study the influence of the grain size and other parameters on the spot dimension. Here an attempt has been made for determining the average grain size of polycrystalline material (Quartz Powder) without taking recourse to standardization. The method is based on the study of the variation of the spot dimension with the specimen to film distance. Quartz powder of known average grain size

(– 270 + 300 BSS mesh) has been selected for this study. Thin specimen of thickness 0·02 cm has been prepared using quick fix as the cementing material. Transmission diffraction patterns of this sample have been obtained on a universal flat plate camera by keeping the film in the range of 2 to 8 cm distance from the sample at regular intervals of 1 cm. The sample was irradiated with Cu-Kα radiation at 30 kV and 15 ma with an exposure time varying from ½ an hour to 1½ hours. The average spot dimension on 101 reflection of quartz has been meassured on all the diffraction patterns and a graph (Fig. 1) is drawn between the spot dimension (S) and the sample to spot distance (l) which is linear and the intercept of this line on the ordinate may be taken as a measure of the average grain size (G) in accordance with the equation[5] $S = G + Gl/f^1$ where f is the distance of a point source behind the sample.

In this case the intercept, *i.e.*, the spot dimension at zero specimen to spot distance agreed with the mesh size.

The authors acknowledge with thanks the encouragement given by Prof. K. V. Krishna Rao and Prof. Abde Ali, Osmania University.

Univ. College of Sci., G. GOPALAKRISHNA.
Univ. College of Tech., R. B. RAMCHANDER.
Osmania University,
Hyderabad-7, *September* 17, 1971.

---

1. Rooksby, *J. Roy. Soc. Arts*, 1942, **90**, 673.
2. Stephan and Barnes, *J. Inst. Metals*, 1937, **60**, 285.
3. Krishna Rao and Gopala Krishna, *Curr. Sci.*, 1963, **32** (5), 207.
4. Clark and Zimmer, *Applied X-ray* by Clark, G. I., McGraw-Hill Book Co., Inc., N.Y., 1940.
5. Gopala Krishna and Ramchander, *Int. J. Rock Mech Min. Sci.* 1971 (*in press*).

$^1n \rightarrow {}^1\pi$ TRANSITION IN ISOMERIC CYANOPYRIDINE VAPOUR ABSORPTION SPECTRA

LONGEST wavelength band system corresponding to the $n \rightarrow \pi$ transition of three isomeric cyanopyridine has been studied in vapour phase. Though the near ultraviolet absorption spectra of pyridine[1,2] and monosubstituted pyridines with ortho-para directing substituents like alkyl[2] and halogens[3,4] have been extensively studied, there is very little work on the corresponding vapour absorption spectra of isomeric monosubstituted pyridines with meta directing substituents like cyanopyridines or pyridine aldehydes. Such derivatives are being studied here and result of cyanopyridines being reported. There has been some work on solution spectra of these compounds[5] but vapour spectra have not been studied so far. Longest wavelength band system corresponding to the ^1n–$^1\pi$ transition has been recorded and analysed. The second system corresponding to the 'π–π' transition, however, gives a few broad bands.

On the basis of theoretical considerations[6], it has been shown that meta directing substituents are expected to shift the nonbonding electron transition to the longer wavelength side and that the order of shift would be $2 < 3 < 4$ isomers. Secondly Jaffe *et al.*[7] have calculated the transition energies of various transitions for a number of isomeric monosubstituted pyridines including cyanopyridines. There are some significant differences in the two results. A detailed experimental investigation of spectra of cyanopyridine to get true transition energy was hence thought important.

The longest wavelength system extending from 3000–2800 Å in all the isomers consists of extended system of sharp line like bands well separated from diffuse system adjoining on shorter wavelength side. That the sharp system corresponds to ^1n–$^1\pi$ transition is convincingly proved by the fact that the theoretical calculations discussed above indicate that such transition is expected. Apart from this, solvent effect in solution spectra shows that long wavelength tail of the broad absorption bands is due to n–π transition. In 4-cyanopyridine with C_{2v} symmetry this corresponds to 1_{B_2}–1_{A_1} transition and in other two isomers with C_s symmetry this corresponds to A″–A′ transition. The transitions are symmetry allowed in all three cases. All the bands observed in $n \rightarrow \pi$ transitions of 4-, 3- and 2-cyanopyridines have been analysed. 0–0 band has been assigned in all cases on the basis of temperature effect and analysis of hot bands involving ground state frequencies. 0–0 bands of pyridine and the three derivatives are tabulated in Table I. The various ground and excited state frequencies

TABLE I

Position and shift of 0–0 band in cyanopyridines

Compound	Position of 0–0 band (n, π) cm^{-1}	Shift of 0–0 band from pyridine in cm^{-1}
Pyridine	34769	..
2-Cyanopyridine	34067	702
3-Cyanopyridine	33648	1121
4-Cyanopyridine	32149	2620

involved in the whole system have been tabulated in Table II. The agreement between ground state frequencies obtained from electronic spectra and infrared spectra investigated here is satisfactory. It is important to note that the order of shift observed is $2 < 3 < 4$ as expected by Mason[5] and that our results do not corroborate the calculations of Jaffe *et al.* according to which maximum shift is expected for the 2-isomer. The detailed paper dealing with infrared and electronic spectra will be published elsewhere.

TABLE II

Principal excited state fundamentals of cyanopyridines

Compound	Fundamental modes ν_{6a}	ν_{12}	ν_1	ν_{13}
2-cyanopyridine	446 (462)	726 (775)	949	1154
3-cyanopyridine	415 (475)	718 (782)	981 (1010)	1163
4-cyanopyridine	445	721	958	1179

Values in brackets are corresponding ground state frequencies observed from the ultraviolet spectra.

Department of Chemical
Technology,
University of Bombay,
Matunga, Bombay-19,
October 4, 1971.

M. R. PADHYE.
A. K. GOWARDHAN.

---

1. Sponer, H. and Stuklen, H., *J. Chem. Phys.*, 1946, **14**, 101.
2. Rush, J. H. and Sponer, H., *Ibid.*, 1952, **20**, 1847.
3. Pandey, B. R., *Indian J. Pure appl. Phys.*, 1967, **5**, 288.
   — and —, *Ibid.*, 1968, **42**, 269.
4. Misra, T. N., *Indian J. Phys.*, 1960, **34**, 381.
5. Mason, S. F., *J. Chem. Soc.*, 1959, p. 1247.
6. Orgel, J., *Ibid.*, 1955, p. 121.
7. Del Bene, P. and Jaffe, H. H., *J. Chem. Phys.*, 1968, **49**, 1221.

COMPLEXES OF DIETHANOLAMINE WITH NICKEL (II) SALTS

THE hydroxylamines derived from glycols, *viz.*, mono, di, triethanolamines have been recently subjected to extensive investigations due to their ability to behave as both nitrogen- and oxygen- co-ordinating ligands. In earlier work[1-4] greater emphasis has been given to the complexes formed in solution phase and little is reported about the complexes in the solid state. Spectrophotometric studies[5] of nickel (II) complexes with monoethanolamine show that the ligand behaves as a chelating agent. Recently, crystalline complexes of Ni (II) salts with triethanolamine[6-8] have been investigated in detail and significant conclusions about their structure and stereochemistry reached. In the present communication we briefly report on the synthesis and structure of several complexes of diethanolamine with Ni (II) salts. The complexes were characterized using infra-red and electronic spectroscopy, magnetic susceptibility, X-ray diffraction and electrical measurements.

Generally the complexes were prepared in the present work by the addition of diethanolamine to an alcoholic solution of the nickel (II) salt (in 2 : 1 molar ratio of ligand to metal) and evaporating the solution in dry atmosphere. The crystals separated were washed with alcohol and ether and preserved in dry conditions. By this method the following complexes were prepared: $[Ni(DO)]Cl$; $[Ni(DO)(DOH)]Br$; $[Ni(DOH)_2]I_2$; $[Ni(DO)(DOH)]NO_3$; $[Ni(DOH)_2]SO_4$; $[Ni(DOH)_2](NCS)_2$; $[Ni(DO)(DOH)]ClO_4$; $[Ni(DOH)_2](OAc)_2$, where DOH is diethanolamine and DO is its monodeprotonated form. An yet another type of thiocyanate complex, namely, $[Ni(DO)(DOH)]NCS$ was prepared by treatment of the compound $Ni(NCS)_2 \cdot 4py$[9] (py = pyridine) suspended in methanol, with an excess of diethanolamine. The compositions of the complexes were arrived at by determining the nickel by dimethylglyoxime and by elemental analysis for others. All the complexes were soluble in alcohol and were readily decomposed on contact with water.

The electronic spectra and magnetic susceptibility measurements indicated unambiguously that all the complexes reported above are pseudo-octahedral. Their magnetic moments at 30° C were generally in the range 2·85–3·19 B.M. and the diffuse reflectance spectra of the powdered complexes showed the three *d-d* transitions $^3A_{2g} \rightarrow {}^3T_{1g}$ (P), $^3A_{2g} \rightarrow {}^3T_{1g}$ (F) and $^3A_{2g} \rightarrow {}^3T_{2g}$ (F) characteristic of octahedral Ni(II) complexes. The three bands had maxima in the region 25000–27000, 15500–17500 and 9500–10500 cm^{-1} respectively, which are again characteristic of Ni (II) pseudo-octahedral complexes containing oxygen and nitrogen mixed ligands. Thus in most of the complexes diethanolamine and the monodeprotonated form appear to be ligated to Ni(II) through the N- as well as the O- sites of coordination. Detailed information on the preparation, properties and structure of the complexes will appear elsewhere.

Department of Chemistry, Indian Institute of Technology, Madras-36, *September* 20, 1971.
B. G. SEJEKAN.
M. R. UDUPA.
G. ARAVAMUDAN.

---

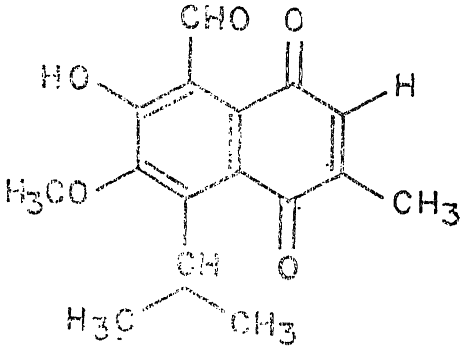
1. Heiber, W. and Levy, E., *Z. anorg. chem.*, 1934, **219**, 225.
2. Tettamanzi, A. and Carli, B., *Gazz. Chim. Ital.*, **1933**, **63** 566.
3. — and Carelli, F., *Ibid*, 1933, **63**, 570.
4. Duff, J. C. and Steer, E. H., *J. Chem. Soc.*, 1932, p. 2861.
5. Udevenko, V. V. and Duchinski, Yu, S., *Russ. J. Inorg. Chem.*, 1967, **12**, 517.
6. Hughes, M. N. and Rutt, K. J., *J. Chem. Soc.*, 1968, p. 2788.
7. Kuge, Y. and Yamuda, S., *Bull. Chem. Soc. Japan.*, 1969, **42**, 2552.
8. Sen, B and Dotson, R. L., *J. Inorg. Nucl. Chem.*, 1970, **32**, 2707.
9. Allan, J. R., Brown, D. H., Nuttall, R. H. and Sharp, D. W., *J. Chem. Soc.*, 1966, p. 1031.

PHENOLIC COMPONENTS OF *BOMBAX MALABARICUM* (ROOT-BARK)

IN an earlier investigation Seshadri and Rangaswami[1] isolated lupeol, β-sitosterol and β-sitosterol-D-glucoside from the stem bark of *Bombax malabaricum* DC. The root-bark has now been studied. The petroleum ether extract was fractionated into the sodium bicarbonate-, sodium carbonate- and sodium hydroxide-soluble and neutral fractions and each was examined separately. Column chromatography of the neutral portion over neutral alumina yielded lupeol and β-sitosterol.

The sodium carbonate-soluble fraction on chromatography over silica gel yielded a pure compound A which crystallised as yellow needles from petroleum ether, m.p. 87–88° (Yield, 0·01%). It analysed for $C_{16}H_{16}O_5$ (M^+ 288), gave an orange colour with $FeCl_3$, a dark-red solution with conc. H_2SO_4 and a violet colour with dilute aq. sodium hydroxide. λ_{max} nm (log ϵ) : 248 (4·18), 272 (4·12) and 338 (3·6) suggestive of a naphthoquinone structure. It showed carbonyl absorption in the IR supporting this structure. The NMR spectrum of the compound in $CDCl_3$ revealed the presence of an isopropyl group [doublet centred at δ 1·26, $J = 7$ cps (6 H) and a multiplet at δ 4·35 (1 H)], a C-methyl group as a doublet at δ 2·06 coupled to the quinone proton which appeared as a quartet at δ 7·32, and an OCH_3 group (*s*, δ 4·07). No aromatic proton was present but peaks due to CHO proton (δ 10·6) and a chelated OH group (δ 12·46) were observed. Methylation of the compound with CH_3I/K_2CO_3 yielded a methyl ether, the IR of which showed aldehyde absorption at 1706 cm^{-1}. Its NMR had two $-OCH_3$ peaks at δ 3·97 and δ 4·08.

The above data suggested that the compound might be a naphthoquinone containing an *O*-hydroxyaldehyde, an isopropyl and a methoxyl group on the aromatic ring. The compound showed a general resemblance to the dimethyl ether of gossypolone in the NMR spectrum[2]. Based on these and on the mass spectrum of the compound, which among other things showed evidence for the presence of an isopropyl group (loss of 43) and of carbonyl (loss of 28 mass units), structure I which is also biogenetically sound is proposed for it.



(I)

The sodium bicarbonate soluble fraction yielded a small amount (0·001%) of compound B, orange needles from petroleum ether, m.p. 167–68°, $C_{15}H_{14}O_5$ (M^+ 274). It gave an orange colour with $FeCl_3$ and a red solution with conc. H_2SO_4 ; λ_{max} nm (log ϵ) : 234 (4·02), 252 (3·99) and 294 (3·85) ; ν_{max}^{Nujol} 1639 cm^{-1}. In NMR sepectrum the compound showed all the functional groups present in A, except that the peak due to $-OCH_3$ was absent. Hence it was considered to be the corresponding dihydroxy compound. This was confirmed by the methylation of B with CH_3I/K_2CO_3 when a partial methyl ether agreeing with compound A was formed initially, which, on further reaction, was converted into the complete methyl ether, identical with the methyl of A.

The authors thank Prof. T. R. Seshadri for his kind interest and the Central Council for Research in Indian Medicine and Homoeopathy for financial assistance.

Department of Chemistry,
University of Delhi,
Delhi-7.
August 20, 1971.

V. SESHADRI.
A. K. BATTA.
S. RANGASWAMI.

---

1. Seshadri, R. and Rangswami, S., *Ph.D. Thesis* of Seshadri, R., Delhi University, 1970 (Unpublished).
2. Hass, R. H. and Shirley, D. A., *J. Org. Chem.*, 1965, **30**, 4111.

THE ALKALOIDS OF *ASPHODELUS MICROCARPUS*

THE genus *Asphodelus (Liliaceae)* is represented in Egypt by 4 species; two of these, *viz.*, *A. microcarpus* and *A. fistulosus* are common while the other two, *viz.*, *A. viscidulus* and *A. refractus* are rare. Of the two common species *A. microcarpus* is the most widely spread species.

Few *Asphodelus* species have been a subject of interest to investigators particularly their lipids and anthraquinones[1-4]. β-sitosterol and β-amyrin were separated from the seeds of *A. microcarpus* and *A. fistulosus*; while fucosterol was isolated from the tubers of *A. microcarpus*[4].

Only limited investigations of the alkaloidal constituents of the genus *Asphodelus* have been made. Klein and Pollauf[5] recorded evidence for the presence of colchicine in *A. albus*, but this was refuted by Santavy[6]. Initial screening of the seeds of *A. microcarpus* and *A. fistulosus* revealed the presence of alkaloids in both species[3].

The study of the lipids, anthraquinones as well as of certain active constituents of the tubers of *A. microcarpus*, growing in Egypt, had been recently carried out by the authors[4,7-9]. This paper deals with the study of the alkaloids of the tubers.

Experimental and Results.—One kg of the defatted powdered tubers was extracted with ethanol 90% in percolator. The dark brown solvent-free extract was taken with H_2SO_4 5% and filtered. The precipitate (anthraquinones)[7] was filtered off and the filtrate was shaken with successive portions of benzene, chloroform, then with ether and the washings were rejected. The acidulated solution was rendered alkaline with ammonia and then shaken with benzene (A), followed by ether (B) then chloroform (C). The crude yellowish-brown solvent-free residues amounted to 0·05, 0·24 and 0·06 gm respectively; all had the same qualitative picture (TLC) and therefore they were combined.

The alkaline mother liquor was rendered acidic with dil. HCl to pH 2, warmed on a water-bath for 15 minutes, filtered and then treated with 2% aqueous solution of ammonium reineckate. The solution was kept at 0° C overnight, then filtered. The precipitate, on the funnel, was dissolved in acetone and CaO was added. The acetone-free residue was dissolved in methanol (500 ml) and then passed through exchange resin (IR 400) and the eluate was evaporated *in vacuo* at 50° C (D, 1·1 gm).

Both paper and thin-layer chromatography, using different solvents, revealed the presence of 3 constituents in fractions A–C and 2 in fraction D (Table I). The alkaloidal spots were detected by UV, as well as by spraying with modified Dragendorff's[10] and iodoplatinic acid[11] reagents.

TABLE I

The R_f and colour of the components detected in the Alkaloidal Fractions

Component No.	Paper chromatography				Thin-layer chromatography*				Detection		
	A	B	C	D	E	F	G	H	U.V.	Dragendorff	Iodoplatinic acid
I	0·37	0·13	0·16	0·33	0·01	0·01	0·12	0·01	B	Orange	+ ve
II	0·67	0·51	0·52	0·63	0·23	0·21	0·49	0·26	B	,,	− ve
III	0·90	0·83	0·90	0·90	0·90	0·90	0·90	0·90	G	,,	− ve
IV	..	..	0·42	0·40	0·02	0·01	0·01	0·12	..	+ ve	+ ve
V	..	..	0·45	0·48	0·14	0·10	0·36	0·12	..	+ ve	+ ve
Choline (Authentic)	..	..	0·42	0·40	0·02	0·01	0·01	0·12	..	+ ve	+ ve
Stachydrine (Authentic)	..	..	0·45	0·48	0·14	0·10	0·36	0·12	..	+ ve	+ ve

* *Absorbent:* Silica gel G; G = Green, B = Blue.

Solvents: A—BuOH : ACOH : H_2O (4 : 1 : 5), B—BuOH : ACOH : H_2O (50 : 1 : 49), C BuOH : ACOH : H_2O (49 : 1 : 50), D—BuOH : ACOH : H_2O (50 : 10 · 50), E—Methanol, F—Benzene : Methanol (30 : 70), G—Methanol-Water (60 : 40), H—BuOH-ACOH-Water (4·1·5).

Trials to obtain either of the three former constituents, after fractionation by preparative TLC, in a crystalline form were unsuccessful. The pharmacological screening[9] of them revealed interesting and promising results; two are spasmolytic and one is spasmogenic.

Colchicine, colchceine, colchamine, demecolcine, jervine, cornigerine and rubjervine were proved to be absent by PC and TLC and by the failure of the alkaloidal extract to give any colour specific for colchicine[12,13].

Fractionation of the Water-Soluble Alkaloidal Fraction (D).—Fraction D was fractionated into the two alkaloids by preparative TLC (using silica gel G) and applying the solvent system methanol-water (60 : 40).

Stachydrine.— The alkaloid possessing the higher R_f, crystallised from absolute ethanol was identified as stachydrine (m.p., m.m.p., 234–235° C). The hydrochloride melted at 219–220° C (undepressed) (Found: C, 46·3; H, 7·8; N, 7·5. $C_7H_{13}O_2N \cdot HCl$, m.p., 222° C[14] required: C, 46·8; H, 7·8; N, 7·8%). The picrate melted at 195–197° C (Lit.[14] 199–200° C).

Choline.—The picrate melted at 245–247° C (Found: C, 39·46; H, 4·63; N, 16·49. $C_{11}H_{16}N_4O_8$, m.p. 245° C[15] required: C, 39·76; H, 4·86; N, 16·87%). The chloroaurate melted at 250–252° C (undepressed).

The presence of stachydrine in *Asphodelus microcarpus*, a plant belonging to the family *Liliaceae*, seems to be the first record of this alkaloid in the family.

Pharmaceutical Sciences F. M. HAMMOUDA.
Laboratory, A. M. RIZK.
National Research M. M. ABDEL-GAWAD.
Centre,
Dokki, Cairo, Egypt,
July 31, 1971.

---

1. Khan, S. A., Qureshi, M. I., Bhatty, M. K. and Karimullah, *J. Amer. Oil Chemists Soc.*, 1961, **38**, **452**.
2. Van Rheede van Oudtschoorn, M. C. B., *Phytochemistry*, 1964, **3**, **383**.
3. Fell, K. R., Hammouda, F. M. and Rizk, A. M., *J. Pharm. Pharmacol.*, 1968, **20**, 646.
4. Rizk, A. M. and Hammouda, F. M., *Plants Medica*, 1970, **13**, 168.
5. Klein, G. and Pollauf, G., *Öst. bot. Z.*, 1929, **78**, **251**.
6. Santavy, R., *Ibid.*, 1956, **103**, 300.
7. Rizk, A. M., Hammouda, F. M. and Abdel-Gawad, M. M., *Phytochemistry*, 1971, (In press).
8. Hammouda F, M., Rizk, A. M., Ghaleb, H. and Abdel-Gawad, M. M., *Planta Medica*, 1971 (In press).
9. Ghaleb, H., Rizk, A. M., Hammouda, F. M. and Abdel-Gawad, M. M., *Qualitas Planterum et Materiae Vegetabiles*, 1971 (In press).
10. Munier, R. and Macheboeuf, M., *Bull. soc. chim. biol. France*, 1952, **19**, 852.
11. Stahl, E., *Dünschicht-Chromatographie*, Springer-Verlag, Berlin/Göttingen/Heidelberg, 1967.
12. Smolenski, S. J., Crane, F. A. and Voigt, R. E., *J. Am. Pharm. Ass. Sci. Edn.*, 1958, **47**, 359.
13. Smith G., Bullivant, A. M. and Cox, P. H., *J. Pharm. Pharmacol.*, 1963 **15**, suppl., 92 T.
14. Heilbron, I., Cook, A. H., Bunbury, H. M. and Hey, P. H., *Dictionary of Organic Compounds*, Oxford University Press, Vol, V, 1965.
15. El-Dakhakhny, M., *Planta Medica*, 1965, **13**, **23**.

A PRELIMINARY NOTE ON FOSSIL POLYCHAETA FROM THE CRETACEOUS ROCKS OF SOUTH INDIA

FOSSIL record of polychaetes reaches back into the Cambrian period and as in other regions, they are known to occur in Indian subcontinent also in various rock formations. Our geological literature, however, rarely gives more than a mere mention of them as *annelids* or *worms* or *serpulids*. Hardly a dozen species have been so far described in any detailed manner[1-5], seven of them being from the Cretaceous rocks of South India described by Stoliczka[3,4] nearly a hundred years ago.

Recent collections of fossils made by us from the Cretaceous rocks of South India have revealed a rich and varied polychaetan fauna, mostly coming from the Uttattur and Ariyalur Groups. Our study has revealed among them several new species, as also some genera, *e.g.*, *Spirorbula*, *Rotularia*, *Glomerula*, *Serpentula* and *Terebellolites*, which were not known to occur in these South Indian strata. The species which we have so far been able to identify in our collection include: *Serpula filiformis* Sow., *S. ootatoorensis* Stol., *S. hamata* Forbes, *S. rugosa* sp. nov., *S. mallurensis* sp. nov., *Ditrupa brevituba* sp. nov., *Glomerula gordialis* (Schloth.), *Serpentula ampullacea* (Sow.), *Rotularia rotuloidea* sp. nov., *R. callosa* (Stol.), *R. discoidea* (Stol.), *Spirorbula crispans* sp. nov., *S. sinuirugosa* sp. nov., *Burtinella concava* (Stol.) and *Terebellolites* sp.

Tubilosteum Stoliczka (now a synonym of *Rotularia* Defrance[6]) and *Burtinella* Mörch are polychaetan and not gastropodous genera as considered by Stoliczka[3].

Morphological features of determinative value available for study in polychaetan fossil material being not many nor easy to study, this group of organisms has been generally neglected by palaeontologists as material not of much use for stratigraphical purposes or for age considerations. However, for these very reasons and accepting the limitations inherent in the nature of the material available for handling, it is desirable that polychaetan fossils are critically studied and all available information about their morphological features placed on record so that in course of time it may be possible to sort out such of the morphological details as we may be able to employ more gainfully than has hitherto been possible to do.

Detailed report on these fossils will appear elsewhere.

M.A.C.S. Research Institute,
Poona-4, *August* 17, 1971.

G. W. CHIPLONKAR.
P. M. TAPASWI.

---

1. D'Archiac and Haime, *Descrpt. anim. foss. gr. Nummulitique l'Inde.* 1853.
2. Kossmat, F., *Rec. Geol. Surv. India*, **30** (2), 1897.
3. Stoliczka, F., *Pal. Ind. Ser.*, V, **2** (5), 1867-68.
4. —, *Ibid.* Ser. VIII, **4**, 1872-73.
5. Waagen, W., *Pal. Ind. ser.* XIII, **1** (5), 1855,
6. Howell, B. F., *Treatise on Invertebrate Polaeontology*, Ed. by R. C. Moore, Pt. W. Worms, 1962.

DISCOVERY OF VERTEBRATE FOSSILS FROM THE KARGIL BASIN, LADAKH (JAMMU AND KASHMIR)

THE note records the occurrence of vertebrate fossils from the Kargil basin about 120 km north-east of Srinagar (Kashmir). The other known occurrence of vertebrate fossils from the Transhimalayan zone is from the Hundes region of Tibet[1] about 385 km from the Kargil basin. The fossils under study were collected during the course of an expedition to Ladakh organised by the Centre of Advanced Study in Geology, Panjab University, Chandigarh, in August, 1970.

The vertebrate fossils described here come from a 60 cm thick bed of red shale occurring in the lower part of the Ladakh Molasse Group (Mio-Pliocene)[2] about 125 m south of Baroo Colony in a section exposed along the Kargil-Shanko road. The collection consists of a tooth and broken fragments of a limb bone. As the tooth and the limb bone occur together in the same bed, it is tentatively inferred that these belong to the same animal. Beds above and below the bed containing vertebrate fossils are rich in plant fossils.

DESCRIPTION OF FOSSILS

Molar (Fig. 1).— Upper molar, preservation excellent, squarish in shape, median valley deep, cusps in the form of ridges. Metastyle, parastyle and mesostyle not well developed. Cingulum prominent at the anterior and posterior ends. The length and breadth are 23 and 25 mm respectively. The tooth is comparable with that of *Hyoboops* of the Miocene of East Africa.

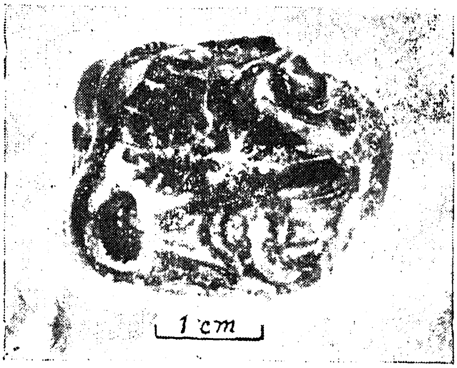


FIG. 1. Crown view of the tooth.

Femur (Fig. 2).—Fragments of the limb bone belong to femur. The bone is broken at the distal and proximal ends and therefore no details are observable. The median shaft of the femur is, however, prominent. Breadth and thickness at the proximal end are 37 and 22 mm respectively, while at the distal extremity they measure 28 and 22 mm respectively. The length could not be measured precisely as some parts of the bone are missing. Copper mineralization is characteristic and forms the inner layer of the fossil.

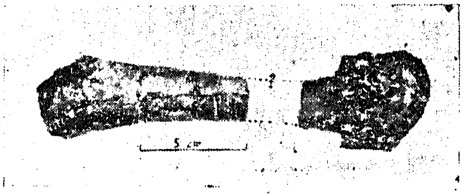


FIG. 2. Anterior view of the femur.

The occurrence of these vertebrate fossils indicates that the lower part of the Ladakh Molasse Group may probably be of Miocene age.

The authors are thankful to Prof. I. C. Pande, Director, Centre of Advanced Study in Geology, Panjab University, for organising the expedition, providing facilities, and constant encouragement. Thanks are also due to Dr. R. J. G. Savage of the University of Bristol, Shri S. P. Jain and Shri A. C. Nanda for their help.

Centre of Advanced
Study in Geology,
Panjab University,
Chandigarh-14,
August, 9, 1971.

P. C. Dixit.
R. K. Kachroo.
H. Rai.
N. L. Sharma.

---

1. Strachey, R., *Quart. Jour. Geol. Soc.*, London. 1851, **7**, 292.
2. Tewari, A. P., *Proc. XXII Int. Geol. Cong.*, Part XI, 1964, p. 37.

HISTOMORPHOLOGY OF MECKEL'S DIVERTICULUM IN TWO SPECIES OF BIRDS

Mitchell (1901) and earlier workers have described the retention of a portion of the embryonic yolk sac as a diverticulum of the intestine in many adult birds. Mitchell termed this Meckel's diverticulum because of its homologous structure in man. According to his observations, where there is a diverticulum it is usually "a functionless rudiment of an embryonic structure". A lumen may or may not be present, and, when present, it contains "a few fragments of materials resembling yolk". Mitchell's microscopical observations of Meckel's diverticulum in some birds led him to see the resemblance between the mucosa of Meckel's diverticulum and the mucosa of paired caeca. Further work on this interesting organ is completely wanting (Farner, 1960). In order to understand the nature of this diverticulum, its occurrence and histomorphology were studied in two species of birds, *Tringa glareola*, Linnaeus and *Calidris temminckii*, (Leisler).

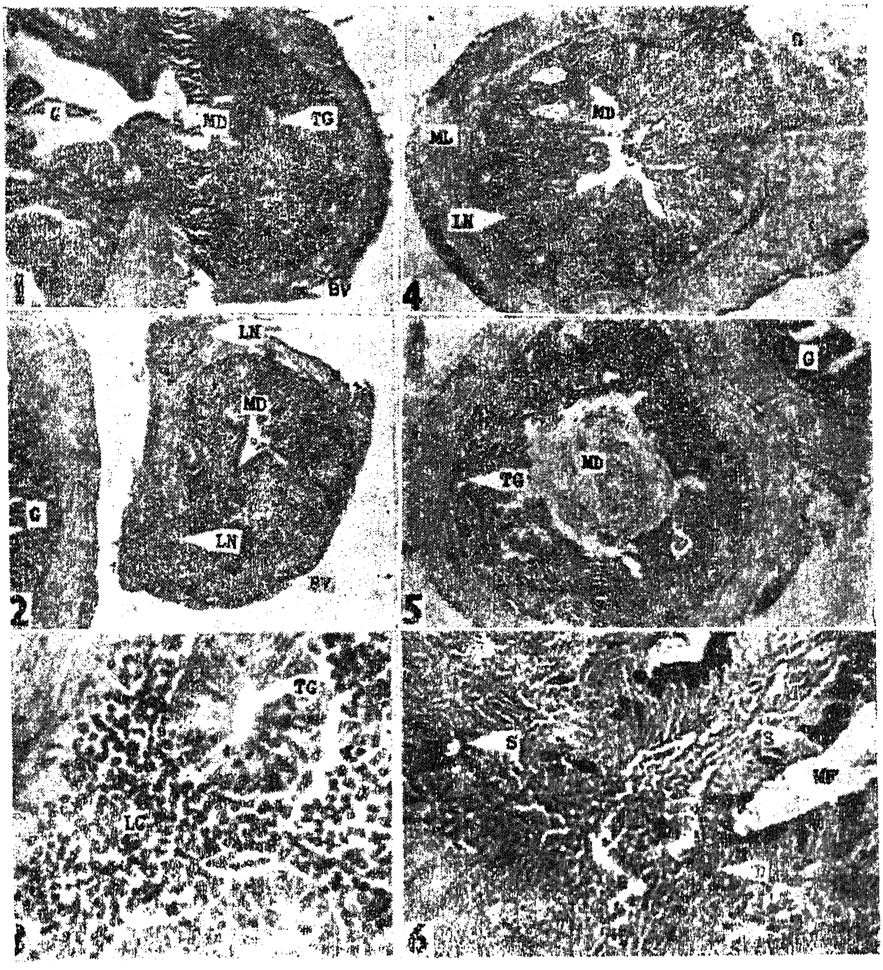
Specimens of *Tringa* and *Calidris* were caught on the banks of Adyar river estuary, Madras, and in the paddy fields of the nearby area, and were transported to the laboratory. The birds were killed and the body cavity was opened to examine the whole alimentary canal as to the occurrence of Meckel's diverticulum. The Meckel's diverticulum was separated from the alimentary canal along with a small portion of the intestine and fixed in Bouin's fluid overnight. Following paraffin embedding $6\,\mu$ thick sections were cut and stained with Heidenhain's hematoxylin and eosin (HE) to observe the histological structure, and with aldehyde fuchsin (AF) (Gabè, 1959) to observe the secretory materials.

In *T. glareola* and *C. temminckii* Meckel's diverticulum is conspicuous. In *Tringa* this diverticulum measures about 8 mm in length and is located about 10 cm posterior to the duodenum and 8 cm anterior to the paired caeca. In *Calidris* it measures about 4 mm in length and is situated about 5 cm posterior to duodenum and 6·5 cm anterior to the caeca. The diverticulum tapers to a narrow end and is always projected forward.

Histological preparations of the diverticulum (Figs. 1–6) show the existence of a narrow lumen that opens into the intestine. The lumen often contains materials resembling those present in the adjoining small intestine. The wall of the diverticulum is very thick. Internally it has a single layer of mucosal epithelium with columnar cells. This mucosa is thrown into small and irregular folds. A few tubular glands are present below the mucosal layer, and they open into the lumen by straight ducts. These glands appear similar to the intestinal glands, in structure. The space between these glands is filled with numerous lymphocytes packed loosely and in the form of nodules. The lymphatic nodules are lymphocytes within spherical connective tissue capsules. Externally, the diverticulum is surrounded by a thick layer of circular muscle. The muscle layer is also often infested with lymphatic nodules. Blood vessels are also found embedded in the muscle layer. An interesting feature in Meckel's diverticulum of these species is the occurrence of a large number of mitotic phases in the glandular cells and lymphocytes. Besides, when stained with aldehyde fuchsin, many cells in the mucosal epithelium, glandular cells and some cells along the duct of these glands exhibit the presence of strongly basophilic secretory products which appear to be very similar to those of the mucus secreting globlet cells of the intestine.

The observations on Meckel's diverticulum of *Tringa* and *Calidris* clearly indicate that this structure is not just a vestige in the adult, but it has some secretory, and, perhaps, digestive function. The presence of mitotic stages among the gland cells, secretory products in the gland cells and materials within the lumen of the diverticulum resembling those in the intestine support the active nature of this structure. Occurrence of profuse lymphocytes and lymphatic nodules with mitotic stages also suggests a possible role of Meckel's diverticulum in lymphocyte production. Presence of glands and lymphatic nodules were also recorded by Mitchell (1901) in a few birds. Mitchell attempted to draw an inverse correlation between the size of Meckel's diverticulum and the size of the paired caeca. It is noteworthy that while Meckel's diverticulum is prominent in both *Tringa* and *Calidris* the paired caeca differ in size in the two species; in *Tringa* the caecum measures about 5 mm in length and in *Calidris* it measures about 15 mm. As observed by Mitchell the present study shows a general structural resemblance between Meckel's diverticulum and the caeca. A detailed study of caeca of these birds will be reported elsewhere.

The authors are grateful to the authorities of Pachaiyappa's College, Madras, for facilities. The assistance of the Zoological Survey of India in the identification of specimens is acknowledged with thanks.



FIGS. 1-6. Photomicrographs of transverse sections through Meckel's diverticulum in *Calidris* and *Tringa*. Fig. 1. *Calidris*. Section showing the communication between the gut and the diverticulum. Stain, HE. Fig. 2. *Calidris*. Section through the distal end of Meckel's diverticulum showing lymphatic nodules in the muscle layer. Stain, HE. Fig. 3. *Calidris*. Tubular glands with mitotic stages and lymphocytes in the wall of Meckel's diverticulum. Stain, HE. Fig. 4. *Tringa*. Section showing the lumen connection between Meckel's diverticulum and the gut. Stain, HE. Fig. 5. *Tringa*. Distal end of the diverticulum showing tubular glands, lymphocytes and lymphatic nodules in the mucosa. The lumen contains materials resembling gut contents. Stain, HE. Fig. 6. Mucosal folds and tubular glands in Meckel's diverticulum with aldehyde fuchsin positive secretory materials. Stain, AF.

Arrow heads, Mitotic stages; BV, Blood vessels; D, Duct; G, Gut; LC, Lymphocytes; LN, Lymphatic nodules; MD, Meckel's diverticulum; MF, Mucosal fold; ML, Muscle layer; S, Secretory materials; TG, Tubular gland.

Department of Zoology, N. P. KALYANAM.
Pachaiyappa's College, N. GURUMANI.
Madras-30, *July* 24, 1971.

1. Farner, D. S. and Marshall, A. J. (ed.), *Biology and Comparative Physiology of Birds.* Academic Press, New York, 1960, **1.**
2. Gabé, M., *Bull. Micr. Appl.* Paris, 1959, **2,** 154.
3. Mitchell, P. C., *Trans. Linn. Soc.* (London), 1901, **8,** 173.

EFFECTS OF STARVATION ON TISSUE RESPIRATION OF SOME THERMO-CONFORMERS

THERE is a good correlation between mitochondrial content and oxygen uptake of tissues excised from different organs[1]. At structural level, starvation has been shown to cause swelling, rounding and loss of certain parts of the mitochondria in fishes and rats[2]. Decreasing trends in the oxygen uptake of different tissues excised from the fasting rats have been demonstrated as function of starvation stress[3]. Studies on the oxygen consumption of thermo-conformers as function of starvation have so far been made only at the organismic level[4-6]. This note reports on the changes in the tissue respiration levels of some important organs of the starving fish *Ophiocephalus striatus* and frog *Rana hexadactyla.*

Individuals of *O. striatus* (about 4 g) and *R. hexadactyla* (about 14 g) were fed in the laboratory for a few days and subsequently starved (at 23° ± 1° C). From the stock, one starving fish was killed every alternate day; liver and muscle were excised from it and immediately transferred into cold physiological saline (0·9% NaCl). Almost every day a frog was pithed and its brain, liver and leg muscle tissues were removed and transferred into frog's ringer[7]. Oxygen uptake of the tissues was measured following the standard manometric procedure described by Umbreit *et al.*[8].

Liver of the fish consumed 404 $\mu l/g/h$ on the zero day of starvation (Fig. 1); its oxygen uptake decreased to 270 and 190 $\mu l/g/h$ on the 3rd and 10th day of starvation, respectively. Decrease in the oxygen consumption of liver was remarkably more during the initial period than during the subsequent period of starvation. Muscle too exhibited a similar trend in its oxygen uptake; its oxygen consumption was 45 and 15 $\mu l/g/h$ on the zero day and the 36th day of starvation.

Oxygen uptake of brain of a well-fed frog was 401 $\mu l/g/h$ (Fig. 1); it gradually decreased to 350 $\mu l/g/h$ for that of the frog starved for 40 days and then, remarkably to 213 $\mu l/g/h$ for that of the frog starved for 60 days. Oxygen consumption of liver of the frog decreased rapidly during the first 4 days of starvation (from 301 to 185 $\mu l/g/h$); subsequently, it gradually decreased to 95 and 70 $\mu l/g/h$ for that of the frogs starved for 40 and 60 days, respectively. Thigh muscle of the frog displayed more or less similar decreases in its oxygen consumption it was 211 and 47 $\mu l/g/h$ for that of the frogs starved for zero and 60 days.

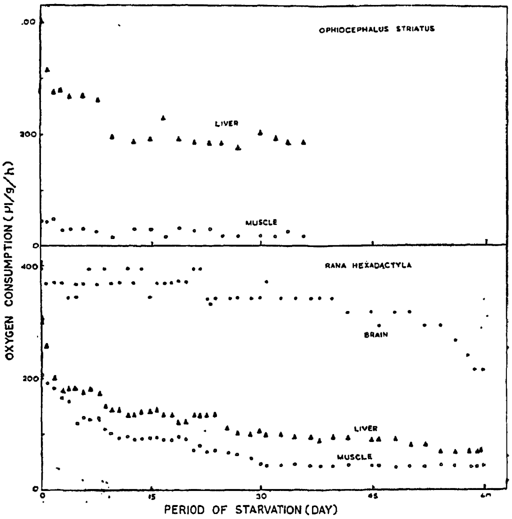


FIG. 1. Oxygen consumption of brain, liver and muscle of the fish *Ophiocephalus striatus* above and the frog *Rana hexadactyla* (below) as funciion of period of starvation.

In both the species, liver and muscle displayed a rapid decrease in the oxygen consumption during the initial period of starvation; this was followed by a gradual decrease during the subsequent days of starvation. Oxygen uptake of liver of well-fed fish and frog was more than 300 $\mu l/g/h$, while that of muscle of the frog and fish was 211 and 45 $\mu l/g/h$, respectively; the oxygen uptake of the muscles are relatively low, as a considerable part of energy requirements of muscle is met by anaerobic decomposition of glucose[9]. Decreasing trends of the oxygen uptake of these 2 reserve organs (liver and muscle) resemble those obtained for the starving lung fish[4] and the frog[6]. Smith[4] found that rate of oxygen consumption of the straving lung fish decreased logarithmically with starvation upto 300 days. Hill[6] observed that the starving frog reduced its oxygen uptake to 60% of the initial level within a week and after this initial rapid reduction, it did not appreciably decrease its oxygen consumption. It is evident from the present studies that the oxygen consumption of the starving frog's brain is maintained at about 90% and 85% of the initial level until the 20th and the 40th day of starvation, respectively and subsequently, rapidly decreased to about 55% of its initial level on the 60th day of starvation.

Reduction in the oxygen uptake of tissues of starving animals is brought about through the decrease in mitochondrial content, and the consequent inhibition of oxidation owing to the deficiency of one or more enzymes in the Kreb cycle. This reduction is set in different organs after different periods of starvation stress. For instance, inhibition of oxidation occurs in the liver of the starving frog (before the 15th day of starvation) earlier than that of brain (between the 40th and the 60th day of starvation). Pandian and Ramachandra Rao[10], who have investigated the effects of extracts of brain of well-fed or starved frog on the tissue respiration, have shown that the extract of brain of the 50-day starved frog depressed the oxygen uptake of tissues (liver and brain) excised from the well-fed frog, while that of the well-fed frog enhanced it in these tissues of the 50-day starved frog.

We are grateful to Prof. K. Pampapathi Rao, F.A.Sc., Bangalore University, for helpful suggestions and for facilities. A Junior Research Fellowship awarded to one of us (RRR) by the CSIR, New Delhi, is gratefully acknowledged.

Zoology Department, R. RAMACHANDRA RAO.*
Bangalore University, T. J. PANDIAN.**
Bangalore-1, India, *August* 5, 1971.

---

* Present address: Zoology Department, S.V. University, Tirnpati (A.P.).

** Present address: Madurai University P.G. Centre, Sri Palaniandavar Arts College, Palani, Tamil Nadu,

1. Prosser, C. L. and Brown, F. A., Jr., *Comparative Animal Physiology*, W. B. Saunders, Philadelphia, 1962.
2. Brachet, J. and Mirsky, A. E., *The Cell*, Vol. 2, Academic Press, New York, 1963.
3. Kleiber, M., *The Fire of Life*, Academic Press, New York, 1961.
4. Smith, F. W., *J. cell. comp. Physiol.*, 1953, **6**, 43.
5. Beamish, F. W. H., *Trans. Am. Fish. Soc.*, 1964, **93**, 103.
6. Hill, A. V., *J. Physiol.*, 1911, **43**, 379.
7. Cavenaugh, G. M., *Formulas and Methods, Mar. Biol. Lab.*, Woodshole, 1966.
8. Umbreit, W. W., Burris, R. R. and Stauffer, J. F., *Manometric Techniques*, Burgess Publishing Co., Minneapolis, 1959.
9. Giese, A. C., *Cell Physiology*, W. B. Saunders, Philadelphia, 1968.
10. Pandian, T. J., and Ramachandra Rao, R., *Experientia* (communicated).

NOTE ON A CASE OF DEATH DUE TO JELLY FISH STING IN GULF OF MANNAR

THE danger of jelly fish stings has been reported by Phisalix (1922), Pawlowsky (1927), Henderson (1945), Halstead (1957, 1959) and Barnes (1963). The venomous nature of the jelly fishes like *Chiropsalmus* sp. (sea-wasp), *Cyanea* sp. (sea-blubber), *Dactylometra* sp. (sea-nettle), and the siphonophores like *Physalia* sp. (Portuguese man-o-war) has been described by Light (1914), McNeil and Pope (1943), Pope (1953), Chu and Cutress (1954), Southcott (1959) and Halstead (1965, 1969).

Apparently death due to jelly fish sting has not been reported so far from India. On 8-7-1971, one fisherman from Keelakarai (Gulf of Mannar) was found missing during the operation of a shore seine in *Appa thievu*, an island seven miles off Keelakarai. When his body was recovered from the sea next day, there were blisters and inflammatory rashes on face, neck, right side of the chest and stomach. Some of the blisters had burst open exposing the wounds. These evidences seem to indicate death due the sting of jelly fishes like *Chiropsalmus* sp., which is known to occur in Gulf of Mannar and is known in Tamil as *Naalu moolai chori* (*Naalu* = four, *moolai* = corner, *chori* = jelly fish). Its sting is known to cause similar symptoms as above (Halstead, 1965).

Such a conclusion is also borne out by an earlier instance. In April 1971 a fisherman of the same village was also stung on the abdomen and waist. He could not be saved even though he was removed to a boat in an unconscious state immediately after the sting. He died before reaching the shore. It is also reported that the tentacles removed from his body, falling accidentally on others, caused severe pain and inflammatory rashes lasting three days. There appear to have been three deaths during this year due to the sting of the jelly fish in Keelakarai.

According to Halstead (1959) the symptoms of jelly fish sting are shooting pain, reddening of the skin followed by severe inflammatory rashes, blistering, swelling and minute skin haemorrhages. In severe cases in addition to shock there may be muscular cramps, abdominal rigidity, vomiting, sensation of constriction of throat, respiratory difficulties and convulsion resulting in death. Death may take place within 30 seconds to 3 hours, but the usual time is less than 15 minutes (Halstead, 1969) due to allergic shock and respiratory failure.

Applying alcohol over the areas of the sting or the removal of the adhering tentacles with sand, sea-weed or wet cloth is essential for preventing further release of nematocysts. Though morphine, intravenous calcium gluconate, oral histamines and dilute ammonium hydroxide or olive oil are used as medicament, there is no specific antidote for jelly fish sting (Halstead, 1959).

I am thankful to Dr. R. V. Nair, Deputy Director and Shri. C. Mukundan, Assistant Fishery Scientist, Regional Centre of Central Marine Fisheries Research Institute, Mandapam Camp, for critically reading the manuscript and offering their suggestions.

Regional Centre, R. S. LAL MOHAN.
Central Marine Fisheries
Research Institute,
Mandapam Camp, *August* 2, 1971.

1. Barnes, J. H., *Bull. post grad. commn. Med. Univ Sydney*, 1963, **18** (3), 103 (Suppl.).
2. Chu, G. W. T. C. and Cutress, C. E., *Proc. Hawai Acad. Sci.*, 1954, **29**, 9.
3. Halstead, B. W., *Armed force Med J.*, 1957, **8** (11), 1587.
4. —, *Dangerous Marine Animals*, Cornell Maritime Press, Cambridge, U.S.A., 1959.
5. —, *Poisonous and Venomous Marine Animals of the World, Invertebrata* U.S. Govt. Printing Office, Washington, 1965, 1.
6. —, *Encylopedia of the Marine Resources*, Edited by F. E. Firth, van Norstrand Reinhold Company, 1969, p. 675.
7. Henderson. H. J., *Brit. Med. J.*. 1945, **30**, 4417.
8. Light, S. F., *Philipp. J. Sci.*, 1914, **9** (3), 291.
9. McNeil, F. A. and Pope, E. C., *Aust. J. Sci.*, 1943, **5** (6), 188.
10. Pawlowsky, E. N., *Gifttiere und Giftigkeit*, Gustav Fischer Jena., 1927.
11. Phisalix, M., *Animaux vinimeux et venins*, Masson et Cie, Paris, 1922, **1**, 656.
12. Pope, E. C., *Aust. Mus. Mag.*, 1953, **11** (1), 16.
13. Southcott, R. V., *Milit. Med.*, 1959, **124** (8), 569.

OIL-BODIES IN SOUTH INDIAN LIVERWORTS

THE hills of South India, particularly Nilgiri and Palni hills, show a highly luxuriant liverwort flora. Numerous leafy plants belonging to Jungermanniales are represented in these areas and stand in need of systematic investigation. An important aspect of oil-body types of these plants have never been investigated. Since the oil-body types have considerable significance in circumscription of the various taxa of leafy liverworts, efforts are being made to elucidate their structure as far as possible in genera and species of liverworts growing all over the country.

Only recently oil-body types of Indian liverworts received some attention[1]. The present paper gives the first account of oil-bodies in species of liverworts from Palni hills, South India. The specimens were collected by Mr. K. P. Singh from Kodaikanal during December–January, 1970–71.

1. *Frullania evoluta* Mitt. (Fig. 1).—The oil-bodies are 3–7 in each cell of the leaf. They are elliptical, sometimes oval or spherical, 3·05–5·08 μ long and 3·0–4·1 μ broad, smooth in outline, containing somewhat prominent granules.

2. *Frullania* sp. (Fig. 2).—The oil-bodies are 4–8 in each cell of the leaf. They are globose or sub-globose, 1·01–4·07 μ in diameter, sometimes slightly elongated, 2·03–3·05 μ long and 1·01–3·03 μ broad, regular in outline, faintly granular.

3. *Frullania neurota* Taylor (Fig. 3).—The oil-bodies are 2–4 in each leaf cell. They are usually spherical or sub-globose, 3·05–5·08 μ in diameter, rarely elliptical, 4·07–6·1 μ long and 3·05–5·0 μ broad, smooth in outline, containing somewhat prominent granules.

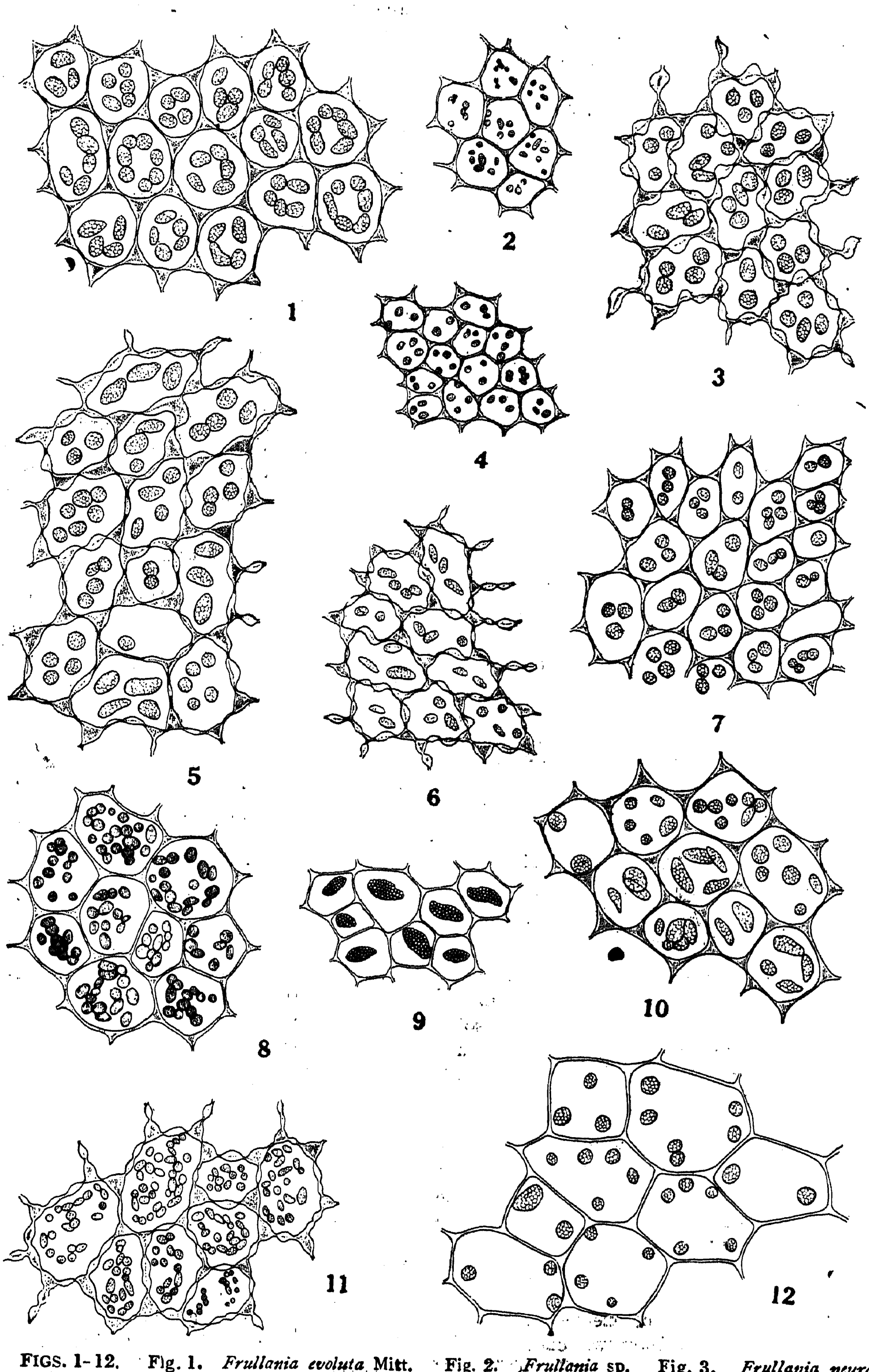
4. *Frullania tamarisci* (L.) Dum. (Fig. 4).—The oil-bodies are 2–5 in each cell of the leaf. They are usually spherical, 1·01–2·03 μ in diameter, rarely oval or slightly elongated, 2·0–3·05 μ long and 1·15–2·1 μ broad, regular in outline, faintly granular.

5. *Frullania squarrosa* Nees (Fig. 5).—The oil-bodies are usually 1–6 per leaf cell. They are usually elliptical or spindle-shaped, 5·08–7·01 μ long and 3·0–4·07 μ broad, rarely spherical, 2·1–5·18 μ in diameter, smooth in outline with prominent granules.

6. *Frullania wallichiana* Mitt. (Fig. 6).—The oil-bodies vary from 2 to 4 in each leaf cell. They are usually elliptical or slightly elongated, 4·07–6·1 μ long and 2·03–5·08 μ broad, rarely spherical 3·08–4·07 μ in diameter, smooth in outline with somewhat prominent granules.

7. *Frullania gracillima* St. (Fig. 7).—The oil-bodies vary from 2 to 3 (4) per leaf cell. They are usually spherical or globose, 3·05–4·07 μ in diameter, rarely elliptical, 4·01–5·08 μ long and 2·03–3·05 (–5·08) μ broad, smooth in outline, containing granules.

8. *Porella acutifolia* L. *et* L. (Fig. 8).—The oil-bodies are numerous (7–19) per cell, in the middle, at the margin and at the base of the leaf. They are mostly globose or sub-globose, 2·1–5·25 μ in diameter, rarely elliptical, 3·1–4·0 μ long and 2·03–3·0 μ broad, smooth in outline, containing minute granules,



FIGS. 1-12. Fig. 1. *Frullania evoluta* Mitt. Fig. 2. *Frullania* sp. Fig. 3. *Frullania neurota* Taylor. Fig. 4. *Frullania tamarisci* (L.) Dum. Fig. 5. *Frullania squarrosa* Nees. Fig. 6. *Frullania wallichiana* Mitt. Fig. 7. *Frullania gracillima* St. Fig. 8. *Porella acutifolia* L. *et* L. Fig. 9. *Leucolejeunea xanthocarpa* (K. *et* L.) Evans. Fig. 10. *Bazzania tridens* Nees. Fig. 11. *Spruceanthus semirepandus* (Nees) Verd. Fig. 12.

9. *Leucolejeunea xanthocarpa* (L. et L.) Evans (Fig. 9).—The oil-bodies are one in each cell, in the middle, at the margin and at the base of the leaf. They are usually elliptical or spindle-shaped, elongated, about 8·1–10·15 μ long and 4·0–4·8 μ broad, irregular in outline, prominently granular.

10. *Bazzania tridens* Nees (Fig. 10).—The oil-bodies vary from 2 to 7 in each cell of the leaf. They are usually elliptical, 4·0–10·17 μ long and 3·0–4·17 μ broad, rarely spherical, 2·0–4·07 μ in diameter, smooth in outline with somewhat prominent granules.

11. *Spruceanthus semirepandus* (Nees) Verd. (Fig. 11).—The oil-bodies are numerous in each cell, in the middle, at the margin and at the base of the leaf. They are usually spherical or globose, 1·4–3·08 μ in diameter, rarely elliptical, 3·8–4·07 μ long and 1·8–2·03 μ broad with regular outline and faintly granular.

12. *Lophocolea* sp. cf. *heterophylla* (Schrad.) Dum. (Fig. 12).—The oil-bodies are usually 2–6 in each leaf cell. They are spherical, rarely elliptical, 2·1–5·08 μ in diameter, smooth in outline and faintly granular.

Department of Botany, RAM UDAR.
University of Lucknow, VIRENDRA NATH.
Lucknow, *July* 15, 1971.

---

1. Udar, R., Srivastava, S. C. and Kumar, D., "Oil-bodies in Indian liverworts," *Curr. Sci.*, 1970, **39**, 458.

STUDIES ON SANDAL SPIKE

Part IX.* Cation Exchange Capacity of Sandal (*Santalum album* Linn.) in Health and Disease

SANDAL (*Santalum album* L.) is a root hemi-parasite which derives its sustenance partly from the host plant[1,2] and partly from the soil[3]. However, during the early growth of the plant, upto about an year, it can live by itself, thereby suggesting that its root system is fully capable of taking up the required mineral nutrients directly from the soil at that stage. It is also known that with the onset of the spike disease (mycoplasmal in nature[4,5]) the haustorial connections cease and the tree gradually dies; this suggests that the direct nutrient intake is very much restricted, if at all it exists. Hence the cation exchange capacity (C.E.C.) of the roots of one-year old sandal plants (healthy) and well-grown ones (healthy and spiked) has been studied. The C.E.C. of some of the important host plants has also been studied, since it may throw some light on the host-parasite relationship.

The various well-grown plants, used for collecting root samples, were selected from the field, while the one-year old plants were grown in pots using the same soil as was occurring around the grown-up plants in the field. Separate samples were taken from ten plants in each category. Following the procedure of Crooke[6], the C.E.C. was determined by replacing the exchangeable cations in the root powder by hydrogen ions by treatment with excess of dilute hydrochloric acid, subsequently exchanging these hydrogen ions by potassium ions by treatment with excess of normal potassium chloride solution, and estimating the hydrogen ions thus liberated with standard dilute potassium hydroxide using either glass electrode or phenol red to indicate the endpoint. The results are presented in Table I.

TABLE I

C.E.C.† of sandal and some of its hosts

	One-year old	Well-grown
1. Sandal ..	22·0–24·0 (without host) 26·0–27·5 (with *Gliricidia maculata* as host) 18·5–20·0 (with *Casuarina equisetifolia* as host)	10·5–12·0 (both healthy and diseased)
2. *Casuarina equisetifolia*	37·5–39·0	17·5–20·0
3. *Lantana camara*	24·0–26·0	22·0–23·5
4. *Gliricidia maculata*	14·0–16·0	26·0–27·5
5. *Pongamia glabra*	14·0–15·0	18·0–20·5
6. *Cassia siamia*	12·0–13·5	10·5–12·0

† Milliequivalents per 100 g of dry root (average of 6 determinations).

From the above results it is seen that the C.E.C. of one-year old sandal plants is of a high order comparable to other plants[6], and it partly explains its ability to live without a host in the early stages. The C.E.C., however, gets reduced and stabilised as the plant grows, suggesting that even at the grown-up stage, sandal is capable of drawing its mineral requirements to some extent directly from the soil. Further, the C.E.C. is in no way affected by the onset of the spike disease, while the mineral content in the diseased plant gets reduced[7,8]. It, therefore, appears that severance of haustorial connections, the second channel for the mineral intake, in the spiked sandal is mainly responsible for the decrease in the total mineral content in it.

Another noteworthy point is that the C.E.C. of *Cassia siamea*, which is known to be a good host for sandal, is almost equal to that of sandal. It is, therefore, to be seen whether the proximity of the C.E.C. of a plant to that of sandal is one of the criteria to serve as a good host.

Forest Research Laboratory,
Bangalore-3,
August 12, 1971.

K. Parthasarathi.
S. K. Gupta.
P. S. Rao.

---

* Part VIII has appeared in the *Proceeding of the Indian Academy of Science*, 1970, **72 B**, 277.

1. Varadaraja Iyengar, A. V., *Indian Forester*, 1965, **91**, 246 and 341
2. Ramaiah, P. K., Parthasarathi, K. and Rao, P. S., *Proc. Ind. Acad. Sci.*, 1962, **56 B**, 111.
3. Sreenivasa Rau, Y. V., *J. Ind. Inst. Sci.*, 1933, **16 A**, 167.
4. Varma, A., Chenulu, V. V., Raychaudhuri, S. P., Nam Prakash and Rao, P. S., *Indian Pytopathology* 1969, **22**, 289
5. Hull, R., Horne, R. W. and Nayar, R. M., *Nature*, 1969, **224**, 1121.
6. Crooke, W. M., *Plant and Soil*, 1964, **21**, 43.
7. Varadaraja Iyengar, A. V., *J. Ind. Inst. Sci.*, 1928, **11A**, 97.
8. Rama Rao, D. A. and Sreenivasaya, M., *Ibid.*, 1928, **11 A**, 241.

OCCURRENCE OF THE ALLIGATOR WEED IN SOUTH INDIA*

The alligator weed *Alternanthera philoxeroides* (Mart.) Griseb, a native of South America, was first reported in India from Bihar and West Bengal (Maheshwari, 1965). This emergent aquatic weed which thrives in waters up to a depth of 2·5 m has been gradually spreading in north-east India in recent years and is now found also in parts of Assam. Early in July, 1970 the weed was collected in the lake at the Lal Bagh Gardens, Bangalore. It is still limited to isolated small patches along the northern shore of this lake, which is heavily infested by *Eichhornia crassipes* as the dominant weed. A few erect shoots of *A. philoxeroides* and *Ludwigia adscendens* were seen amidst dense stands of *Eichhornia*. There has apparently been no previous published record of the alligator weed from South India. The weed is likely to invade other areas in peninsular India as well as North India if timely measures are not taken up to control it in the limited areas of its present distribution. Although the weed produces flowers, seed-setting is rare and the weed propagates almost entirely by vigorous vegetative growth and regeneration of detached and dispersed clumps. The weed is very aggressive and like the water hyacinth it may become a menace to cultivation and inland water transportation. No satisfactory herbicidal controls against the alligator weed are known (Sculthorpe, 1967).

Elsewhere in the south-east Asia *A. philoxeroides* has been recorded only from Burma and Indonesia (throughout western Java), having been first found near Djakarta as far back as in 1875. Most probably it has spread to India from Burma.

In the U.S.A. the alligator weed grows in dense mats over thousands of acres, clogging recreational and flood-control waterways, disturbing wild life habitats and threatening rice cultivation. It is also believed to provide favourable breeding sites for mosquitoes. A leaf-feeding beetle, *Agasicles* sp., which is highly specific to *A. philoxeroides*, has been introduced there from South America and it is reported to be exerting satisfactory control of the weed in some of the infested areas where releases have been made. This biocontrol agent is worth introducing for trials in India. Three species of native insects, *Cassida* sp. nr. *enervis* Boh., *Psara basalis* Wkr. and *P. stultalis* Wkr., are known to attack the alligator weed in India but these have little control value.

The authors are indebted to Prof. Cecil J. Saldanha, S.J., St. Joseph's College, Bangalore, for confirming the specific identification of the weed.

Commonwealth Institute of Biological Control,
Indian Station, Bangalore-6,
August 14, 1971.

T. Sankaran.
E. Narayanan.

---

* This research is financed in part by a grant made by the United States Department of Agriculture under PL-480.

1. Maheshwari, J. K., "Alligator weed in Indian lakes,' *Nature, Lond.*, 1965, **206**, 1270.
2. Sculthorpe, C. D., *The Biology of Aquatic Vascular Plants*, Edward Arnold Ltd., London, 1967, p. 610.

A NOTE ON THE EFFECT OF SIMAZINE ON THE FODDER PRODUCTION OF M.P. CHARI (*SORGHUM BICOLOR*)

Simazine is widely used as a herbicide. However, when it is used in smaller doses, it enhances the crop growth and crude protein yield (Ries, 1968). A trial was laid out at Indian Grassland and Fodder Research Institute, Jhansi, to find out the extent of such benefit on fodder sorghum M.P. Chari. Pre-emergence application of simazine was done to M.P. Chari at the rate of 0, 100, 200, 300, 400 and 500 g a.i./ha over a basal application of 60 kg N and 30 kg P_2O_5 per hectare. The effect of simazine treatments was also compared with 30 kg N/ha soil application given as top dressing at boot stage and the same dose as foliar spray in two equal splits at boot stage and at 5 days interval. The crop was harvested for fodder at 50% heading (77 days growth).

The results indicated that application of 100 g a.i. simazine per hectare increased significantly the green fodder and dry matter yield by 118 q/ha (53·1%) and 31·8 q/ha (60·6%) respectively over the control yields (222 q/ha green fodder and 52·4 q/ha D.M.) without simazine. The effect of 100 and 200 g a.i. simazine per hectare application was statistically at par. Further increases in the simazine level did not benefit the crop. Crude protein yield was also increased by 158 kg/ha (61·4%) due to 100 g a.i. simazine per hectare over control value of 257 kg/ha.

Application of 100 g a.i. simazine per hectare was statistically superior to top dressing of 30 kg N/ha (soil application) giving an increase of 47 q/ha (16·0%) of green fodder and 11·5 q/ha (15·8%) dry matter over 293 q/ha green fodder and 72·7 q/ha of dry matter obtained with top dressed treatment. The effect of 100 g a.i. simazine per hectare was also statistically at par with 30 kg N/ha applied as foliar spray.

Thus, these results indicate the promise of lower doses of simazine to enhance the fodder production and also economise the use of nitrogenous fertilizers.

Indian Grassland and Fodder Research Institute,
Jhansi, *August*, 14, 1971.

N. D. MANNIKAR.
A. S. GILL.
C. T. ABICHANDANI.

---

1. **Ries, S. K., "Spray-on protein boosters,"** ***Crops and Soils*, 1968, 20 (8), 15.**

EFFECT OF FERTILIZER ON THE PROTEIN CONTENT OF RICE

THE effect of NPK fertilizer at two different doses applied to rice plant grown at two different levels of altitude on the protein content and cooking quality was studied.

Five varieties of rice mentioned below were grown at two different doses of fertilizer $N_{40}P_{20}K_{20}$ and $N_{80}P_{40}K_{40}$ kg/ha. Karjat-184, Kosbhat-71 and Taichung Native-1 were grown both on upland and lowland at the Agricultural Institute of Kosbad in wet season 1970-71. Jaya was tested under lowland condition only while Padma was tested under upland condition only. The protein content at the time of harvest was determined by macro-Kjeldhal method and the cooking quality was estimated by iodine coloration[1].

TABLE I

Variety	Level	Fertilizer treatment	Protein percentage	Cooking quality
Jaya	Lowland	Low dose*	7·127	Poor
		High dose†	7·501	
Karjat-184	Upland	Low dose	6·170	Poor
		High dose	6·657	
	Lowland	Low dose	6·539	
		High dose	6·832	
Padma	Upland	Low dose	6·479	Poor
		High dose	6·902	
Kosbhat-71	Upland	Low dose	6·904	Good
		High dose	7·482	
	Lowland	Low dose	7·049	
		High dose	7·492	
Taichung	Upland	Low dose	6·107	Poor
		High dose	6·678	
	Lowland	Low dose	6·314	
		High dose	6·653	

* $N_{40}P_{20}K_{20}$ kg/ha, † $N_{80}P_{40}K_{40}$ kg/ha.

It might be seen from Table I that as the dose of NPK fertilizer increased the protein content of all the varieties of rice grown at two different levels increased. Jaya, Karjat-184, Padma and Taichung Native-1 had poor cooking quality. However, Kosbhat-71 had good cooking quality.

Thanks are due to Dr. N. R. Bhat, Professor, Emeritus and J. S. Patil, Director, Kosbad Agricultural Research Institute, for kindly supplying the samples of rice grown at Kosbad (Thana District, Maharashtra State).

Department of Biochemistry,
Institute of Science,
15, Madame Cama Road,
Bombay-32, *July* 30, 1971.

A. R. CHAVAN.
N. G. MAGAR.

---

1. **Chandraratna, M. F.,** ***Genetics and Breeding of Rice*, Longmans, Green and Co., Ltd., London, 1964, p 297.**

REVIEWS AND NOTICES OF BOOKS

Annual Review of Astronomy and Astrophysics (Vol. 9). (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1971. Pp. vii + 394. Price. U.S.A. $ 10.00 ; Elsewhere $ 10.50.

As will be seen from the titles list given below this year's volume of the *Annual Review of Astronomy and Astrophysics* should be of special interest to readers as it deals with many timely and important subjects.

Several papers, review articles, and conference proceedings dealing with planetary atmospheres have appeared in recent years. Progress in this field has been so rapid that a further survey of the present state of knowledge of the atmospheres of our nearest planetary neighbours on either side of the Earth seems warranted, especially is this so as we are getting valuable data from the space probes Veneras and Mariners. In the article on this subject Ingersoll and Leovy compare the compositions, thermal structures, and dynamics of the lower and upper atmospheres of Mars and Venus, and discuss some problems of their evolution in the light of recent findings.

Another review article of current interest and in which notable progress has been made in the last few years is the one on "Filled-Aperture Antennas for Radio Astronomy" by J. W. Findlay. The name filled-aperture describes the simplest type of radio telescope, one in which the antenna gain and resolution are both determined by the actual size and shape of the antenna aperture. In the unfilled-aperture instruments, such as interferometers, crosses, or synthetic antennas, the resolution is determined by the outer dimensions of the antenna area, much of which is not in fact filled with receiving elements. One of the F-A antenna's described in this article is the parabolic cylinder antenna at Ootacamund, India, designed and constructed by the radio astronomy group of the Tata Institute of Fundamental Research, Bombay. It has a collecting area of 530 × 30 m, with an effective aperture of 9000 m^2.

The contents of the volume are as follows: Meteorites and the Early Solar System by Edward Anders; Dwarf Galaxies, by Paul W. Hodge; Infrared Sources of Radiation, by Gerry Neugebauer, Eric Becklin, and A. R. Hyland; The Nearby Stars, by Peter van de Kamp; Central Stars of Planetary Nebulae by E. E. Salpeter; The Atmospheres of Mars and Venus, by Andrew P. Ingersoll and Conway B. Leovy; Evolutionary Processes in Close Binary Systems, by B. Paczyniski; Ultraviolet Studies of the Solar Atmosphere, by Robert W. Noyes; The Formation of Spectral Lines, by D. G. Hummer and G. Rybicki; Filled-Aperture Antennas for Radio Astronomy, by J. W. Findlay; Physical Conditions and Chemical Constitution of Dark Clouds, by Carl Heiles; Convection in Stars: I. Basic Boussinesq Convection, by E. A. Spiegel; and Recent Developments in the Theory of Degenerate Dwarfs, by Jeremiah P. Ostriker.

A. S. G.

Molecular-Genetic Mechanisms of Development. By Zhores A. Medvedev. (Translated from Russian, by Basil Haigh) (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xiv + 418. Price $ 25.00.

The original Russian text, published in 1968 for the Academy of Medical Sciences of USSR, has been corrected by the author for this English translation. This book is a logical continuation of the author's earlier book "Protein Biosynthesis and Problems of Heredity, Development, and Ageing" published in 1966 (Oliver and Boyd Ltd., and Plenum Press). In this edition while questions of protein biosynthesis are discussed briefly and generally, there is greater emphasis on the molecular-genetic and biochemical aspects of development and differentiation of living organisms. The eight chapters in the book take the reader in a systematic and logical way through the mechanisms of morphogenesis at every level of organization from the virus to the highest multicellular organisms. Besides presenting factual material, they also indicate problems which still require explanation and further study.

The text covers comprehensively among others the following topics: the biochemical mechanisms of transfer of genetic information; reproduction and morphogenesis of viruses; intercellular biochemical differentiation of monochromosal bacterial cells and multicellular organisms; changes in proteins and nucleic acid during processes of differentiation and development; induction of differentiated activity of the genes by cytoplasmic and chromosomal factors.

In the penultimate chapter of the book the author discusses the problem of programmed morphogenesis and gives a theoretical analysis. The last chapter, which is a supplement to this English edition, deals with recent advances in this subject covering the years 1967 and 1968. As a comprehensive text presenting uptodate material on molecular-genetic studies, some of which are not easily available, the book should appeal to all workers on molecular genetics and heredity mechanisms.

A. S. G.

Chemical Mutagens—Principles and Methods for Their Detection (Vols. 1 & 2). Edited by A. Hollaender. (Plenum Pub. Corpn., 227, West 17th Street, New York, N.Y. 10011), Vol. 1: Pp. lxviii + 1–310. Price $ 17.50. Vol. 2: Pp. lxiv + 311–610. Price $ 17.50. Special set price $ 30.00.

Toxic effects of pesticides, food additives, drugs, and other chemical agents have been the cause of much public concern, and they have initiated deep scientific study in recent years. A fact of greater concern is that some of these chemical agents may be the source of genetic harm, the effect of which may not be readily perceived in a short generation but nevertheless may be too hazardous to be ignored in the interest of future populations.

The purpose of these volumes, sponsored by the Environmental Mutagen Society, is to encourage the development and application of testing and monitoring procedures to avert significant human exposure to mutagenic agents. They provide an organized description of the methods now available for detecting chemical mutagens and for determining the relation between them and teratogens and carcinogens.

Volume 1 deals with the molecular mechanisms of mutations, the effects and detection of mutagenesis in DNA, in virulent bacteriophages, mutagenesis studies with *E. coli* mutants with known amino-acid changes, and mutation induction in yeast.

Volume 2 deals with the measurement of the genetic effects of mutagenic treatment on growing cultures, microorganisms, and plant and mammalian germ cells. The chapters include inducing mutations with chemicals in *Habrobracon*, detection of mutations in *Drosophila*, specific locus mutation in mice, dominant lethal mutations in mammals, and human population monitoring.

More than 30 authors who have contributed to the two volumes are all working scientists specialized in their respective fields of study and as such the descriptions and results are authoritative. This two-volume comprehensive treatment providing the present state of knowledge on the principles and techniques of chemical mutagen studies should form a guide to further study on the subject.

A. S. G.

Books Received

Hand-Book of Neurochemistry (Vol. 6)—*Alterations of Chemical Equilibrium in the Nervous System.* Edited by Abel Lajtha. (Plenum Pub. Corpn., New York, N.Y. 10011), 1971, Pp. xxi + 584. Price $ 35.00.

Seminars in Mathematics—V. A. Steklov Mathematical Institute, Leningrad (Vol. 14) —*Boundary Value Problems of Mathematical Physics and Related Aspects of Function Theory.* Edited by O. A. Ladyzhenskaya. (Plenum Pub. Corpn., New York. N.Y. 10011), 1971. Pp. vii + 155. Price $ 15.00.

Computer Graphics in Medical Research and Hospital Administration. Edited by R. D. Parslow and R. E. Green. (Plenum Pub. Corpn., New York, N.Y. 10011), 1971. Pp. ix + 89. Price $ 12.50.

Progress in Electrochemistry of Organic Compounds. Edited by A. N. Frumkin and A. B. Ershler. (Plenum Pub. Corpn., New York, N.Y. 10011), 1971. Pp. vii + 440. Price $ 35.00.

Advanced Computer Graphics—Economics, Techniques and Applications. By R. D. Parslow and R. E. Green. (Plenum Pub. Corpn., New York, N.Y. 10011), 1971. Pp. xiv + 1230. Price $ 47.50.

Advances in Experimental Medicine and Biology (Vol. 13)—*Chemistry and Brain Development.* Edited by R. Paoletti and A. N. Davison. (Plenum Pub. Corpn., New York, N.Y. 10011), 1971. Pp. x + 457. Price $ 22.50.

Carbides Properties Production and Applications. By T. Ya. Kosolapova. (Plenum Pub. Corpn., New York, N.Y. 10011), 1971. Pp. xiv + 298. Price $ 30.00.

3193–71, Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.

THE INDIAN ACADEMY OF SCIENCES, XXXVII ANNUAL MEETING

THE Thirty-seventh Annual Meeting of the Indian Academy of Sciences was held on the 7th, 8th and 9th November, 1971, in Bangalore at the invitation of the Raman Research Institute. It may be recalled that Sir C. V. Raman, Founder and President of the Academy, who died on November 21, 1970 presided over the Thirty-sixth Annual Meeting in September, 1970, also held at the Raman Research Institute. The date of this year's meeting was chosen to coincide with Professor Raman's birthday (7th November, 1888).

The scientific programme for the meeting consisted of three symposia on topics of growing current interest in which work is being done in different parts of the country. This has enabled specialists in these disciplines to meet at a forum to present their results and discuss their problems.

The inaugural session opened on the evening of the 7th November before a large gathering of Fellows of the Academy, Delegates and invited guests. Professor M. G. K. Menon, F.R.S., Director of the Tata Institute of Fundamental Research, Bombay and Chairman of the Board of Trustees of the Raman Research Institute, delivered the Welcome Address. This was followed by the Presidential Address of Professor T. S. Sadasivan, Acting President of the Indian Academy of Sciences, who chose as his subject "Phytochemicals and the Problems of Pollution".

The two sessions on the second day of the meeting were devoted to the *First Symposium* of papers, the subject of which was chosen fittingly enough to honour the memory of Professor Raman. It was "Professor Raman—Some scientific ideas propounded by him and the current status of the relevant fields". The review papers by the participants highlighted the early discoveries of Professor Raman and his collaborators which had left landmarks in the progress of science and the impact of which has opened up resurgent activities in recent research, thanks to modern developments in instrumentation and technology.

In the forenoon session under the Chairmanship of Dr. K. R. Ramanathan, Director, Physical Research Laboratory, Ahmedabad, the following papers were presented: (1) "Properties of Liquid Crystals" by Prof. S. Chandrasekhar (Raman Research Institute, Bangalore), (2) "Professor Raman and Lattice Dynamics" by Dr. G. Venkataraman (Bhabha Atomic Research Centre, Bombay); (3) "C. V. Raman, Optical Spectroscopy and Development of Quantum Electronics" by Dr. S. S. Jha (Tata Institute of Fundamental Research, Bombay); and (4) "Properties of Thin Films" by Dr. S. R. Rajagopalan (National Aeronautical Laboratory, Bangalore).

In the afternoon session under the Chairmanship of Prof. B. V. Thosar of the Tata Institute of Fundamental Research, the symposium continued and the following papers were presented: (5) "Scattering of Coherent Radiation by Diffusing Surfaces" by Prof. P. Hariharan (Indian Institute of Science, Bangalore); (6) "The Optics of Heterogeneous Media" by Dr. S. Ramaseshan (National Aeronautical Laboratory, Bangalore); (7) "The Optics of Polycrystalline Minerals" by Mr. G. S. Ranganath (National Aeronautical Laboratory, Bangalore); and (8) "Modulation of Electron Waves by Laser Beam" by Prof. K. P. Sinha (Indian Institute of Science, Bangalore).

In the evening there was a public lecture by Professor S. Bhagavantam on "Professor Raman and his Work".

The *Second Symposium* of the Meeting under Section A was devoted to recent developments in computer science, theory and applications. This was taken up in the forenoon session on the third day under the Chairmanship of Prof. M. G. K. Menon when the following papers were presented and discussed: (1) "Principles of Scientific Reasoning and Deduction" by Prof. G. N. Ramachandran (Indian Institute of Science, Bangalore); (2) "Computer based Behavioural Studies" by Prof. R. Narasimham (Tata Institute of Fundamental Research, Bombay); (3) "Theoretical Foundations of Computer Science" by Prof. S. K. Basu (Indian Institute of Technology, Kanpur); (4) "The Theory of Formal Languages" by Dr. (Mrs.) R. Siromoney (Women's Christian College, Madras); and (5) "Matrix Formulation of Mathematical Logic" by Prof. E. V. Krishnamurthy (Indian Institute of Science, Bangalore).

The session in Section B, in the afternoon of the 9th November, was devoted to the *Third Symposium* of the Meeting the subject of which was "Biology and Genetics at the Molecular Level". It was chaired by Prof. T. S. Sadasivan and the following papers were presented and discussed: (1) "Molecular Biology and Plant Disease" by Dr. S. Suryanarayanan (Centre for Advanced Studies in Botany, Madras University); (2) Molecular Genetics and Human Disease" by Dr. V. M. Sivaramakrishnan (Cancer Institute, Madras); (3) "Biogenesis of Membranes" by Dr. J. Jayaraman (Madurai University); (4) "Molecular Aspects of Cell Membranes" by Dr. (Mrs.) Kuntala Jayaraman (Madurai University); (5) "Concept of Gene Action" by Dr. P. R. Mahadevan (Bhabha Atomic Research Centre, Bombay); and (6) "Evolution of the Gene" by Dr. T. M. Jacob (Indian Institute of Science, Bangalore).

This Annual Meeting of the Indian Academy of Sciences the content, venue and date of which had special reference to the memory of Professor Raman concluded with an expression of thanks voiced by the Acting President of the Academy, Prof. T. S. Sadasivan, and the Acting Director-in-Charge of the Raman Research Institute, Dr. S. Ramaseshan, to all the Fellows, Scientists, and Invitees who attended the session and especially to the participants in the three symposia who by their original contributions in their respective fields of study made this Meeting a memorable success.

ABSTRACTS OF PAPERS IN SECTION A

Raman and Lattice Dynamics

G. Venkataraman
Nuclear Physics Division
Bhabha Atomic Research Centre,
Trombay, Bombay-85, India

One of the subjects in which Raman became interested in his long and distinguished career was crystal dynamics. Prior to Raman's entry into this field, the important theories of lattice vibration spectra were those of Einstein, Debye and Born. Of these, Raman rejected the Debye and Born theories since it was inconceivable to him that the normal modes could be classified in terms of waves with progressive phase changes. Instead he reasoned that the frequency spectrum must be discrete, rather like what Einstein had suggested. Whereas Einstein assumed that atoms vibrated with a single frequency, Raman proposed from considerations of translational symmetry and the phases of atoms in adjacent cells that the frequency spectrum must consist of $(24p-3)$ discrete frequencies (where p is the number of atoms in the cell), supplemented by a ν^2-type spectrum at the low frequency end to describe waves of an elastic character. The light scattering spectra of several solids obtained by Raman and his collaborators seemed strongly to support this view.

More recently, several other techniques have become available for the study of vibration spectra, the principal among which is slow-neutron scattering. Extensive measurements have shown that the frequency spectrum is not discrete but is continuous and is generally as given by the Born theory. However, the frequency spectrum shows several singularities (the so-called van Hove singularities), the most important among which are those due to modes of vanishing group velocity. The corresponding frequencies are termed critical frequencies. Of the latter, those, determined by the translational symmetry of the crystal are precisely the $(24p-3)$ normal modes considered by Raman. Thus, out of the very large number of normal modes permitted in the Born theory (and whose existence is now confirmed experimentally), Raman's theory focusses attention on a special subset, *viz.*, those which correspond to standing waves and are characterized by the fact that equivalent atoms in adjacent cells have the same or opposite phase.

The fact that Raman concentrated attention on the critical frequencies is interesting because these frequencies play an important role in several context, for example, second-order infra-red spectra, impurity absorption spectra, tunnelling experiments, etc.

With regard to the line spectra seen by Raman and co-workers, the situation now is clear. Actually these spectra are continuous as Born's theory would demand but have strong singular features superposed which often appear as lines. Thus if one confined attention merely to the singular features then one could analyse the spectra in terms of the critical frequencies, as has, for example, been done recently for ZnS. This would be in the same spirit as the analysis as carried out by Raman himself. Another example in this category is provided by the work of Solin and Ramdas who have recently reinvestigated diamond (one of Raman's favourite subjects) *via* laser Raman spectroscopy. They were able to carry out a critical point analysis of the observed spectrum and extract precise values for the critical frequencies which include the set of 9 [the number $(24\,p-3)$ reduces to 9 for diamond owing to the crystal symmetry] originally considered by Raman. The critical frequencies so obtained are in excellent agreement with those obtained *via* neutron scattering.

While Born's theory gives a more comprehensive description of the normal modes than all the other theories, it too has limitations. For example, it fails when applied to quantum crystals like solid helium. Also it does not lead naturally to the phenomenon of diffusion which also forms a part of the gamut of atomic motions in the solid state. In this respect therefore our understanding of atomic motions in solids is still not complete, and further work both theoretical and experimental is necessary.

Colours of Thin Black Nickel Deposits

S. R. Rajagopalan
Material Science Division,
National Aeronautical Laboratory,
Bangalore-17

Professor C. V. Raman's researches on the colours of naturally occurring materials like opals, mother of pearl, etc., stimulated us to investigate the origin of the vivid colours of black nickel deposit. The distinguishing features of these films are : 1. They are metallic —therefore good electronic conductors—yet they exhibit saturated colours up to a thickness of 3000 Å. 2. The colour changes sequentially, *i.e.*, in the order yellow, red, blue, green, yellow, etc., as the thickness of the deposit is increased. 3. The colour is dependent on the refractive index, n_0 of the surrounding medium. It shifts significantly to the blue end as n_0 is increased.

The systematic variation of colour is reminiscent of interference phenomenon. However, the metallic nature and the fact that these films exhibit vivid colours up to 3000 Å make it, at first, difficult to accept the interference hypothesis; this is because metallic films become opaque and reflecting, at thicknesses much smaller than that required for the development of even the first order yellow interference colour.

Professor C. V. Raman's investigations show that colours could result from optical phenomena like scattering, diffraction, etc. He proved that the colours of opals were due to selective reflection from stratified medium while those of mother-of-pearl were the result of laminar diffraction which is a combination of selective reflection and diffraction from a stratified medium. He traced the colours of old decomposed glasses to stratifications at the surface. He demonstrated that these lamellae have open structure and thereby explained the colour changes noticed when bits of old decomposed glasses were immersed in liquids. Black and white experiments were performed to see whether black nickel exhibited the characteristics of any of these phenomena. By a process of elimination it was inferred that the colours of black nickel should essentially be due to the phenomenon of interference in thin layers.

The primary objection to the interference hypothesis is whether black nickel is transparent, at least to a degree, upto 3000 Å. By a simple optical technique the transparency of these deposits was demonstrated. A determination of the optical constants of these films showed, that they—unlike metals—have very low extinction coefficient ($k=0{\cdot}305$) and are therefore weakly absorbing.

A theoretical analysis of the characteristics of interference colours due to weakly absorbing films pointed out that in such films the phase change ϕ_1, (due to reflection at the air/film interface) has to be taken into account in addition to the other phase changes, *i.e.*, the condition for constructive interference turns out to be $\phi_1-\phi_2+2\,\delta=m\lambda$ when $m=1,\ 2,\ 3$ .... when the angle of incidence is zero. In this expression ϕ_2 represents phase change due to reflection at film/substrate interface, and δ stands for the phase difference due to the film thickness. Since ϕ_1 is dependent on refractive index, n_0, of the surrounding medium, it is obvious that the interference colour should be dependent on n_0.

Experimental investigations with black nickel films showed that the direction and magnitude of the colour shift due to changes in n_0 agree with the prediction of the theory; thus establishing that the colours of black nickel are due to interference phenomenon in thin films of a weakly absorbing material.

The interesting optical properties of black nickel is seen to stem from its low extinction coefficient. Such a low k value for a metallic film is rather surprising because metals are characterised by a large k. The reason for the small k is traced to the fact that this deposit consists of a dispersion of metal particles (size 100 Å or less) in a matrix of $Ni_3S_2 + ZnS$.

Diffraction of Coherent Light by Diffusing Surfaces

P. HARIHARAN
Indian Institute of Science, Bangalore

When a diffusing surface is illuminated by the coherent beam from a laser, it exhibits a remarkable granular or speckled appearance, not seen with ordinary light. This is attributed to the formation of a complex, random, stationary interference pattern by the completely coherent diffracted beams from individual elements on the diffuser.

Such speckle patterns, as they are now commonly termed, were initially considered a nuisance in techniques such as holography, involving the use of coherent light sources. More recently, quite a few applications of these patterns have been suggested, such as the detection of mode multiplicity in lasers, and the measurement of the modulation transfer function of photographic materials. A major, rapidly developing field of use is in measurements of surface displacements, including the analysis of vibrating surfaces. For this purpose, these techniques have the advantage that they are relatively simple and can be used in real time for measurements of both normal and in-plane strains. Concurrently, detailed theoretical studies of the statistics of such patterns, when formed under different conditions, have also been made.

In view of the current wave of interest in speckle patterns, and in view of the fact that this earlier work appears to have been overlooked in recent publications, it is interesting to note that essentially the same phenomenon was studied by Professor C. V. Raman as far back as 1919, when he explained the effects observed when a bright point source is viewed against a dark background as due to diffraction by particles in the structure of the eye. Subsequently a quantitative theory of these intensity fluctuations was worked out by G. N. Ramachandran, in connection with a study of coronae, in a paper which anticipated several of the findings of recent studies. One of the most important conclusions reached, which was also experimentally verified, was that the probability distribution of intensities in the pattern could be obtained from Lord Rayleigh's expression for the resultant due to the summation of n vibrations with random phases. Another was that an increase in the aperture of the diffuser must result in the appearance of more spots in the field of view. The existence of an object-image relationship between the source and the spots in the pattern was also established and elegantly demonstrated by varying the size and shape of the source and showing that the spots altered in the same way.

Optics of Heterogeneous Media

S. RAMASESHAN
Materials Science Division,
National Aeronautical Laboratory,
Bangalore-17

One of the important questions to be answered in the field of material science is whether in a polycrystalline or a composite medium the strain continuity condition is violated at the grain boundary, when the material is stressed. Photoelastic measurements on transparent substances appear to be more effective than elastic measurements, for deciding this issue. To make the calculation of the average photoelastic tensor, in a polycrystalline medium, the paper by Raman and Viswanathan on optically heterogeneous media had to be critically evaluated. This was the main motivation the speaker had for studying many of the classical papers of Prof. Raman and his colleagues on the optics of heterogeneous media and a few of these are discussed here.

The Optics of Mirages by Raman and Pancharatnam is an important paper in this field. Here the authors show that the traditional explanation of the mirage as a phenomenon due to total internal reflection is quite untenable. They show that an incident wave splits into a cusped wavefront, the two branches of which form the direct, (*i.e.*, refracted or aberrated) wave and a reflected wave. The general correctness of their theory was proved by the experimental observation of the caustic and the associated fringes. The mathematical techniques used are similar to those used in quantum mechanics. The quantum mechanical analogues of total internal reflection and the mirage are discussed. Reference is also made to Prof. Raman's comments on the Einstein's aberration experiment.

Next, the main results of the paper by Raman and Viswanathan on the optical translucency of polycrystalline materials like jadeite and alabaster are discussed. As this translucency cannot be explained by geometrical optics they have given a simple wave optical explanation. Its generalisation using Mueller matrices and the Poincare sphere by Ranganath and Rama-seshan is presented. When the crystallites are both optically active and birefringent it is shown that in the polycrystalline medium one may easily get $(g_{11}+g_{22}+g_{33})$, where g_{11}, g_{22}, g_{33} are the principal gyration tensor components of the crystal. The absence of rotation noted by Raman and Bhat in polycrystalline quartz is shown to be due to the fact that in quartz by accident $g_{33} = -\frac{1}{2}g_{11} = -\frac{1}{2}g_{22}$. The tensor properties of optically active molecules are next considered and the theory of Raman and Krishnan on flow birefringence is invoked to investigate the new phenomenon of flow optical activity, where there should be a change in optical activity when anisotropic molecules flow. It seems probable that these effects are best seen in substances which show large anomalous rotation. Experiments for the electrical alignment of such molecules are also considered.

From the calculation of photoelastic constants of polycrystalline aggregates it is shown that whether the stress or strain is continuous may easily be distinguished. In some cases especially in polycrystallin alkali halides even the sign of the birefringence may change for the two cases.

Lastly, the methods of identifying the preferred orientation of quartzite which may be caused by earth movements are considered. Here it appears that Raman's method of deducing the orientation of crystallites in polycrystals by studying the diffraction halo appears to be the most promising one.

The Optics of Polycrystalline Minerals

G. S. Ranganath
Materials Science Division,
National Aeronautical Laboratory,
Bangalore-17

Professor Raman has made detailed optical studies of a series of substances from fibrous materials (like silk, cotton, wool, asbestos, glass, rayon) to a group of fascinating gems and minerals (like pearls, fascicular gypsum, agate, moonstone, opal, jadeite, alabaster, etc.). The main method which he used was to send a narrow pencil of light through these and study the transmitted beam and the associated diffraction haloes. From a study of the diminution in intensity and the polarization characteristics of these, he was able to obtain a plethora of information about the optical nature of the major component, state of aggregation, the nature of cementing medium as also the nature of preferred orientation, etc. It is indeed remarkable that in every case the information derived by the simple optical method was confirmed by X-ray and other studies. The series of papers Prof. Raman and his students published in this field are spread over fifty years and can be classified into the following categories: (*i*) Isotropic crystallites in an isotropic medium (Christiansen's experiment), (*ii*) Anisotropic crystallites in an isotropic medium (Christiansen's experiment, opals, pearls), (*iii*) Anisotropic crystallites in an anisotropic medium (Moonstones, Labradorite) and (*iv*) Anisotropic crystallites in aggregation with no cementing medium (Agate, Fascicular gypsum, Alabaster, etc.). Four specific examples are taken to illustrate the techniques employed by Prof. Raman and the information he obtained in: (1) Fibres, (2) Agate, (3) Moonstones and (4) Christiansen's experiment.

Prof. Raman and his collaborators while they made a detailed record of the state of polarization of the direct beam and the diffusion haloes together with their chromatic effects, there was no serious attempt to explain these on a quantitative theoretical basis.

This problem has now been satisfactorily solved by extending the Raman-Nath Theory. A completely polarized plane wavefront entering a polycrystalline aggregate of birefringent crystals emerges from it as an irregularly corrugated and randomly polarized wavefront. This can be split into two orthogonally polarized wavefronts corrugated to different extents. One in the same state of polarization as the incident light wave. These two wavefronts are added in phase (a correlation parameter being introduced for each wavefront) at any part in the field of observation. The results obtained from this theory are in full accord with the detailed experimental observation of Prof. Raman and his collaborators.

Theory of Formal Languages

RANI SIROMONEY
Madras Christian College, Tambaram

Chomsky (1959), formalised the notion of grammar, the motivation being the generation of sentences in natural languages. This attracted the attention of computer scientists, logicians, mathematicians and automata theorists due to the connections established with the syntax of programming languages, recursive function theory, semilinear sets and the construction of automata.

Basic work on the four major formal languages in the Chomskian hierarchy continued. Further, by placing different restrictions on the set of production rules in a grammar new formal languages were introduced in an effort to solve specific problems in compiling, to remove unambiguity in programming languages, to find better approximations to natural languages and to throw light on unsolved problems in earlier work. One aspect of the theory was to introduce a new formal language, construct the corresponding automaton to accept the same set of words, study the closure properties, establish the position of the new language with reference to the Chomskian hierarchy and prove decidability results. Several of the families were closed under certain basic operations. The notion of an abstract family of languages was introduced by Ginsburg and Greibach as a unifying concept to encompass all families of languages closed under union, concatenation, Kleeneclosure, ϵ-free homomorphism, inverse homomorphism and intersection with regular sets.

In addition to placing restrictions on the production rules, by imposing constraints on the manner of applying the rules, we get richer families. In this vein, we have introduced a new family called the equal matrix languages which has several interesting properties. The corresponding Parikh mapping is semilinear, the class of bounded equal matrix languages is unambiguous and characterizes semilinear sets and equal matrix grammar has been used advantageously to generate kernel sentences in Tamil.

Modulation of Electron Waves by Laser Beam

K. P. SINHA
Department of Physics, Indian Institute of Science, Bangalore-12

The scattering of light by matter in various forms, a subject immensely dear to Prof. C. V. Raman, has been discussed by the previous speakers in the context of his pioneering work. I wish to talk about the interaction of light with free electron waves under some unusual conditions leading to puzzling results.

It is a well-known fact that interaction of light with free electrons in the first and second order (Raman scattering) is exceedingly weak. In a recent experiment by Schwarz and Hora, it has been found that electron waves can be modulated when they pass through a thin single crystal film which is bathed in a strong laser beam such that the electric field vector of the light is parallel to the electron beam. Such electron waves falling on an otherwise non-luminescent target emit light of the same colour as the laser light. This experimental observation has been rather intriguing and conflicting explanations have been put forward by various authors. We have shown that a neat quantum mechanical explanation of this effect can be given if one takes account of the discontinuity in the longitudinal component of the electric field produced by the crystalline film. Making use of the path integral approach, it can be shown that the electron current density has the appropriate oscillatory behaviour in time and distance. This is in accord with the experimental observation. The effect seems to be a quantum phenomenon in which each single electron is modulated. There exists the intriguing possibility of observing a temporal counterpart of the Aharonov-Bohm effect if one took account of the proper time.

GRAVITATIONAL FIELD OF A TACHYON

P. C. VAIDYA

Department of Mathematics, Gujarat University, Ahmedabad-9

ABSTRACT

A static axially symmetric exact solution of Einstein's equation $R_{ik} = o$ is interpreted as describing the gravitational field of a tachyon. It is found that under gravitation a tachyon will repel a material particle.

INTRODUCTION

TACHYON is the name given to a 'particle' which moves faster than light. It is known that the existence of free Tachyons is consistent with the consequences of the basic principles of relativity[1], though the problem of causality in relation to Tachyons is still an open question[2,3]. However, it would be interesting to see how one can describe the gravitational effect produced by such 'Faster than Light particles'.

Mathematically one expects the gravitational field produced by a Tachyon to have all the geometrical characteristics of Schwarzschild's field for a point particle; *i.e.*, it will be represented by a static solution of Einstein's equations $R_{ik} = o$ containing a single parameter m and admitting a shear-free, hypersurface-orthogonal null congruence. However, since it will not be possible to get an observer who would observe the Tachyon at rest, the field will have to be axially symmetric (and not spherically symmetric) and must contain an additional characteristic constant a such that $|a| > 1$, the velocity of light being put equal to unity. Further, it should not be possible to transform away this parameter a by a co-ordinate transformation in the case when $|a| > 1$ and in the case $|a| < 1$, it should be possible to choose co-ordinates in such a way that the solution reduces to the spherically symmetric Schwarzschild's solution for a material particle.

THE SOLUTION

The desired gravitational field is described by the line-element

$$\begin{aligned} ds^2 = & -\left(1 - a^2 + \frac{m}{\rho}\right)^{-1} d\rho^2 \\ & - r^2\,(d\theta^2 + \sin^2\theta\, d\phi^2) \\ & + \left(1 - a^2 + \frac{m}{\rho}\right) dt^2, \end{aligned} \tag{2.1}$$

$$r^2 = \rho^2\,(1 - a\cos\theta)^{-2}. \tag{2.2}$$

This metric is static, axially symmetric and satisfies Einstein's equations $R_{ik} = o$. Again it admits a shear-free geodetic null congruence which is everywhere orthogonal to the hypersurface

$$u \equiv t + \int \left(1 - a^2 + \frac{m}{\rho}\right) d\rho = \text{constant}. \tag{2.3}$$

The function r can now be interpreted as the radial co-ordinate and (r, θ, ϕ) as the usual spherical polar co-ordinates in the 3-space II defined by $u - r =$ constant. Thus this axially symmetric solution possesses all the geometrical characteristics of the Schwarzschild's solution for a material particle.

Again if $|a| < 1$, one can transform (2.1) to the form

$$\begin{aligned} ds^2 = & (1 - 2\sqrt{(1 - a^2)}\, M/\rho)\, du'^2 \\ & - r^2\,(d\theta^2 + \sin^2\theta\, d\phi^2) \\ & - 2\,(1 - a^2)^{-1/2}\, du'\, d\rho, \end{aligned}$$

where

$$M = -\frac{m}{2}\,(1 - a^2)^{-3/2}, \quad u' = u\sqrt{(1 - a^2)}.$$

This, in its turn, can be transformed to Schwarzschild's solution

$$\begin{aligned} ds^2 = & \left(1 - \frac{2M}{r'}\right) du'^2 - r'^2\,(d\theta'^2 + \sin^2\theta'\, d\psi^2) \\ & - 2du'\,dr' \end{aligned}$$

by the substitution

$$\cos\theta' = \frac{\cos\theta - a}{1 - a\cos\theta}, \tag{2.4}$$

$$r = \frac{r\,(1 - a\cos\theta)}{\sqrt{(1 - a^2)}}. \tag{2.5}$$

Transformations (2.4) and (2.5) show that the origin O′ moves relative to O with a uniform velocity a in the flat background along the common axis $\theta = o = \theta'$.

Thus the metric (2.1) represents the field of a Schwarzschild-particle moving with a velocity a along the axis $\theta = o$ when $|a| < 1$. And it has all the geometrical characteristics of Schwarzschild's solution even when $|a| > 1$. Therefore in the case when $|a| > 1$, we take this metric as giving us the gravitational field of a Tachyon.

DISCUSSION OF THE GRAVITATIONAL FIELD

The line-element (2.1) has a singularity at $\rho = o$, *i.e.*, at $r = o$ and $\sec\theta = a$ when $|a| > 1$, which gives a right circular cone of semivertical angle α ($\sec\alpha = a$) as the singularity surface. Again the surface $\rho = m\,(a^2 - 1)^{-1} = m\cot^2\alpha = \rho_0$ is a null surface which acts as the 'Schwarzschild's surface' for this gravitational field. This surface is a hyperboloid of revolution and of two sheets in the 3-space II, its equation being

$$\tan^2\alpha\,(\xi + \rho_0\,\mathrm{cosec}\,\alpha\cot\alpha)^2 - R^2 = \rho_0^2\cot^2\alpha$$

with $Z = r\cos\theta$, $R = r\sin\theta$.

The metric (2.1) will define a static gravitational field within that region of the 3-space II in which $1 - a^2 + m/\rho > 0$, *i.e.*, in which $\rho > \rho_0$. This region depends on the sign of the parameter m. Figures 1 and 2 indicate the portion of the (R, ξ) plane (the meridian plane) which generate the regions of validity by rotation round the ξ-axis in the 3-space II, corresponding to the cases $m > 0$ and $m < 0$.

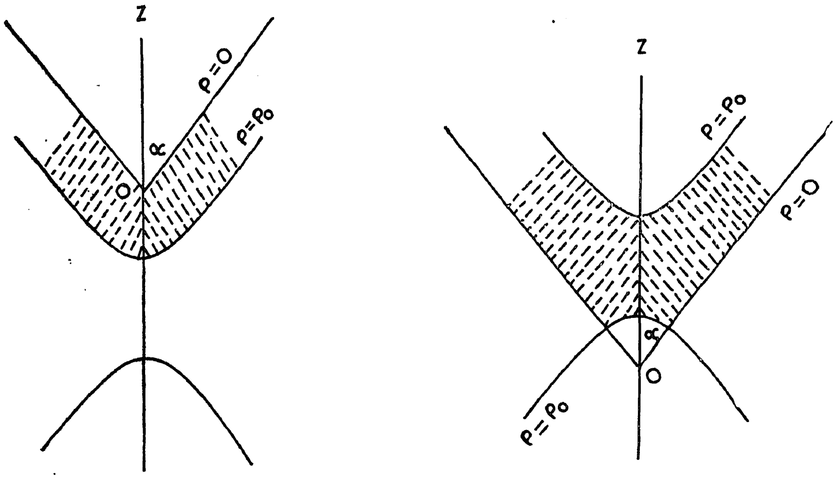


FIG. 1 $m > 0$

FIG. 2 $m < 0$

FIGS. 1–2. The region of validity is obtained by rotating the shaded portion about OZ.

It will be seen from the figures that in both cases the 'black holes' are open and spatial infinity is included in black holes. For the case $m < 0$, the black regions are separated and the singularity $r = 0$ is enclosed in a black hole.

One can write down the equations of geodesics within the region of validity. It is found that a material test particle placed at rest at any point will experience a radial repulsion away from the origin O ($r = 0$) and will have $d\theta/ds = 0$, $d\phi/ds = 0$ all along its path, and so will move away from the origin in the radial direction. Thus the gravitational pull between a Tachyon and a material particle is a repulsive force. It appears therefore that assuming the existence of Tachyons implies assuming the existence of particles which repel material particles under gravity.

---

1. Camenzind, M., *GRG Journal*, 1970, **1**, 41.
2. Glueck, M., *Phys. Rev.*, 1969, **183**, 1514.
3. Rolnick, W., *Ibid.*, 1969, **183**, 1105.

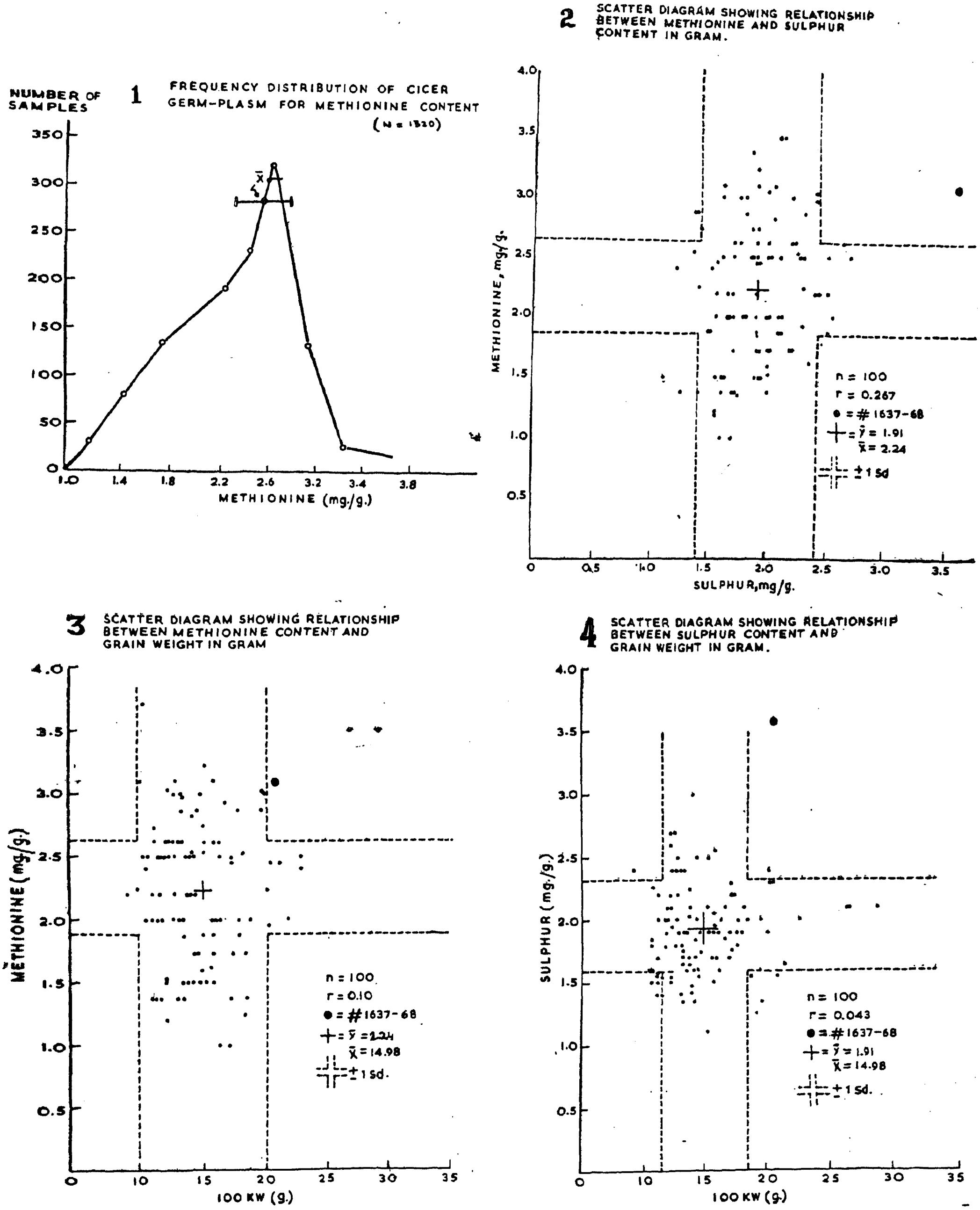
SURVEY FOR A HIGH METHIONINE VARIETY IN THE WORLD COLLECTION OF CHICKPEA

A. K. KAUL AND (MISS) S. GASSI
Nuclear Research Laboratory, I.A.R.I., New Delhi

RESEARCH towards quantitative and qualitative improvement of pulse crops is essential because of the vital role that these crops play in providing a reasonably balanced protein component in the diets of primarily cereal eating people Though, in comparison to cereals, pulses have a higher protein and lysine content, they lack in the sulphur containing essential amino-acids, methionine and cystine, which results in their reduced net protein utilization (NPU).

Indian Agricultural Research Institute maintains the germplasm stock of various pulses in which more than 6,000 cultivated and non-cultivated strains of chickpea are available[1]. The same are being rapidly screened for the crude protein content and methionine content. Already, out of some 1,300 strains screened so far, four high methionine genotypes have been isolated. The results of the survey concluded so far are given.

The samples in the world collection of gram represent cultivated and non-cultivated strains collected from twenty-one countries. For the analysis, random samples were taken from the crop raised under uniform conditions in 1968–69. The samples were milled in a hammer mill to give a particle size of 400 ± 100 microns. The protein content was determined by Auto analyser–colorimetric technique[2]. Total sulphur was determined by the turbidimetric method of Chesnin and Yein (1951)[3] which was slightly modified by replacing ashing with the nitric-perchloric digestion[4].



FIGS. 1-4

Methionine was determined colorimetrically using McCarthy and Sullivan's technique[5] as modified by McCarthy and Paille[6]. The extraction was done after Das and Gupta[7].

The frequency distribution of the samples analysed is depicted in Fig. 1. While the values ranged from 1 to 3·55 mg methionine/g sample, the mean of the 1,320 samples was 2·34 + 0·4 mg/g. As against our earlier report, this detailed study, and the data from other crops, have now revealed that the degree and nature of correlation between sulphur and methionine content vary from crop to crop. In this study, 100 samples out of 1,320 were selected to represent the whole range of methionine content and their sulphur was determined. The mean sulphur content of these samples was 1·91 ± 0·36 mg/g and the mean methionine content was 2·24 ± 0·50 mg/g. As evident from Fig. 2, very low and insignificant correlation ($r = +\,0{\cdot}267$) was obtained. This implies that the crude sulphur content cannot be utilized to predict the methionine content in gram. However, it should be mentioned here that in the absence of a suitable technique for rapid estimation of cystine, it is advisable to estimate the total sulphur content, since methionine gets utilized in place of cystine even if the former is already in short supply in the diet.

A nutritionally superior genotype in any crop plant will be acceptable for cultivation only when it accompanies higher yielding potential as well. In gram, out of the two components of yield, namely, number of grains per plant and the seed weight, the latter parameter is of considerable value in selection with reference to the nutritional quality. It is so because when an amino-acid is expressed on the flour basis rather than on the protein basis, it directly reflects the yield of that amino-acid per unit area. In this study, the grain weight (100 kernel weight) was determined for all the samples. Considerable variation for grain weight was noted. In 100-selected samples the grain weight ranged from 9·16 to 29·11 g/100 kernels, with a mean of 14·98 ± 3·5 g/100 grains. Figures 3 and 4 show that no significant correlation exists between sulphur ($r = 0{\cdot}10$) and methionine content ($r = 0{\cdot}04$) with the 100 KW. However, one of the strains (1637–68) seems to be highly promising since it has very bold grains (100 KW = 20·60 g) and at the same time happens to be having very high methionine (3·10 g/100 g flour) and sulphur content (3·6 g/100 g flour). This strain (shown as a big dot in the figures) was analysed for the total amino-acid (Table I).

TABLE I

Amino-acid composition of = 1637–68 (NP-49) strains of chickpea

Amino-acid	Gram amino-acid/16 g nitrogen
Aspartic acid	11·64
Threonine	3·67
Serine	4·60
Glutamic acid	17·18
Proline	3·99
Glycine	3·86
Alanine	4·20
Valine	4·65
Isoleucine	4·38
Leucine	7·44
Tyrosine	3·19
Phenylalanine	5·61
Lysine	7·26
Histidine	2·61
Ammonia	1·11
Arginine	9·80
Methionine	1·72
Cystine	1·74
Tryptophan	1·12
Protein content	21·5%

The results are expressed as gm amino-acid/16 g N or 100 g protein. The value obtained colorimetrically (3·10 mg/100 g flour) for the methionine content was not significantly different from that obtained by the auto-chromatographic technique (3·68 mg/100 g flour). This genotype should prove of great value in the breeding programmes aimed at producing a bold seeded, high methionine variety of chickpea.

The authors are indebted to the Indian National Science Academy for the financial assistance and Prof. B. Eggum of Landokonomisk Forsoqslaboratorium, Kobenhavn, Denmark, for the amino-acid analysis.

---

1. Anonymous, *New Vistas in Pulse Production*, Indian Agricultural Research Institute, 1971, p. 111.
2. Varley, J. A., *Analyst*, 1968, **91**, 119.
3. Chesnin, L. and Yein, C. H., *Proc. Soil Sci., Soc. Amer.*, 1951, **15**, 149.
4. Shaw, W. M., *J. Agric. Food Chem.*, 1959, **7**, 843.
5. McCarthy, T. W. and Sullivan, M. X., *J. Biol. Chem.*, 1941, **141**, 871.
6. —, and Paille, M. M., *Biochem. Biophys. Res. Commun.*, 1959 **1**, 29.
7. Gupta, V. P. and Das, N. B., *Sci. & Cult.*, 1954, **20**, 90.
8. Swaminathan, M. S., Naik, M. S., Kaul, A. K. and Austin. A., *Improving Plant Protein by Nuclear Technique*, IAEA-SM-132, 130, 1970, p, 165.

LETTERS TO THE EDITOR

INFRA-RED SPECTRUM OF 2, 3-DIFLUOROANILINE

THE spectrum of aniline, the parent compound of 2, 3-difluoroaniline has been the subject of numerous investigations[1,2]. The vibrational studies on its mono- and di-derivatives have been made by several workers [3-7]. Krueger[8], and Krueger and Thompson[9] and Humbley and Grady[10] have confined themselves to the study of the N-H stretching frequency region for a number of substituted anilines. The infra-red studies of 2, 5-difluoroaniline along with other substituted anilines have been made by Singh and Singh[11]. However, no work on the infra-red and Raman study of 2, 3-difluoroaniline seems to have been reported primarily due to the difficulty in synthesizing the molecule. The compound has been recently synthesized by Roe[12]. In the present study the infra-red spectrum of the compound 2, 3-difluoroaniline has been recorded and vibrational assignments for the observed fundamental frequencies have been proposed.

The infra-red spectrum of 2, 3-difluoroaniline has been recorded on a Perkin Elmer double beam Spectrophotometer in the region 700–4000 cm^{-1} with a thin film of the liquid compound between two NaCl windows. The spectra were also recorded by taking the compound with CS_2 of different concentrations. It is observed that the best development of vibrational bands occurs at a particular concentration only. Spectrum has also been recorded on Perkin-Elmer-521 grating spectrophotometer with thin film of the pure liquid between two KRS-5 windows in the region 250–4000 cm^{-1}.

The molecule 2, 3-difluoroaniline belongs to the point group C_s. Taking NH_2 as three different atoms the 36 normal vibrations of the molecule would be subdivided into 25 a' type and 11 a'' type. Vibrations of both these types are allowed in Raman as well as in infra-red spectra. Assignments of fundamental frequencies have essentially been made on the basis of intensity consideration of the infra-red bands, as neither the Raman spectrum nor the infra-red band contours in vapour phase are available. In addition guidance has been taken from the assignments of aniline[1,2], substituted aniline derivatives[3-11], p-difluoro and 1, 2, 4-trifluorobenzene[13] and other related compounds. Table I gives the assignments made for the observed fundamentals in the infra-red spectrum of the molecule.

TABLE I

Observed fundamental vibrational frequencies of 2, 3-difluoroaniline

Frequencies cm^{-1}	Relative intensity		Assignments
3510	10	a''	N-H asym. stretching
3420	10	a'	N-H sym. stretching
3107	6·5	a'	C-H stretching
1630	9·5	a'	N-H bending i.p.
1609	9	a'	C-C stretching
1527	10	a'	,,
1504	10	a'	,,
1453	9	a'	,,
1399	4	a'	C-H bending i.p.
1324	9	a'	C-C stretching
1313	9	a'	C-N stretching
1267	6	a'	C-F stretching
1206	10	a'	,,
1157	10	a'	C-H bending i.p.
1120	9	a'	,,
1070	8	a''	N-H bending o.p.
970	9	a'	C-C stretching (breathing vibration)
916	8	a''	C-H bending o p.
844	6	a''	,,
789	5·5	a''	,,
773	5	a'	C-F bending i.p.
770	5	a'	,,
729	6	a''	NH_2 wagging
713	3·5	a''	C-C-C bending o.p.
600	5	a'	C-C-C bending i.p.
515	3·5	a''	C-F-bending o.p.
497	4·5	a''	C-C-C bending o.p.
412	2·5	a'	C-C-C bending i.p.
291	3	a''	C-C-C bending o.p.

N.B.: i.p., in-plane, o.p., out-of plane.

Authors are thankful to Dr. A. M. Roe of Smith Kline Laboratories, England, for his generous gift of the chemical. They are also thankful to Prof. P. Veskateswarlu, IIT, Kanpur, for permission to use the P.E.-521 grating spectrophotometer. (B.B.L.) and (G.D.B.) are grateful to CSIR, for financial assistance.

Department of Spectroscopy, Banaras Hindu University, Varanasi-5, *July* 17, 1971.

B. B. LAL
G. D. BARUAH.
I. S. SINGH.

---

1. Evans, J. C., *Spectrochim. Acta*, 1960, 18, 428
2. Whiffen D. H., *Ibid.*, 1955, 13, 253.
3. Tiwari, S. K. and Upadhya, K. N., *Indian J. Pure and Appl. Phys.*, 1965, 3. 370.
4. Verma, P. K. and Singh, N. L., *Ibid.*, 1965, 3, 176.

5. Singh, V. B., Singh, R. N. and Singh, I. S., *Spectrochim. Acta*, 1966, **22**, 927.
6. Kohlrausch, K. W. F., Herz, E. and Vogel, R., *Mn. Chem.*, 1947, **75**, 49.
7. —, Stockmar, R. and Vpsilanti, P. G., *Ibid.*, 1936, **67**, 80.
8. Krueger, P. J., *Can. J. Chem.*, 1962, **40**, 2300.
9. — and Thompson, H. W., *Proc. Roy. Soc.*, 1957, **243 A**, 143.
10. Humbley, A. N. and Grady, B. V. O., *Aust. J. Chem.*, 1962, **15**, 626.
11. Singh, S. N. and Singh, N. L., *Indian J. Pure and Appl. Phys.*, 1969, **7**, 250.
12. Roe, A. M., *J. Med. Chem.*, 1969, **12**, 195.
13. Smith, D. C., Ferguson, E. E., Hudson, R. L. and Neilson, J. R., *J. Chem. Phys.*, 1953, **21**, 1457.

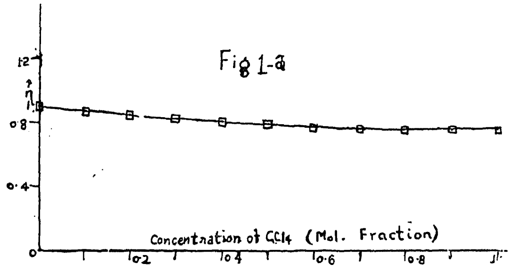
NMR INVESTIGATION OF MOLECULAR ASSOCIATION OF BENZYLAMINE WITH WATER AND CCl_4

INVESTIGATIONS on molecular association of pyridine, quinoline, aniline and *m* and *o* toluidines with liquids like CS_2 and CCl_4 using the NMR technique have been reported earlier[1-3].

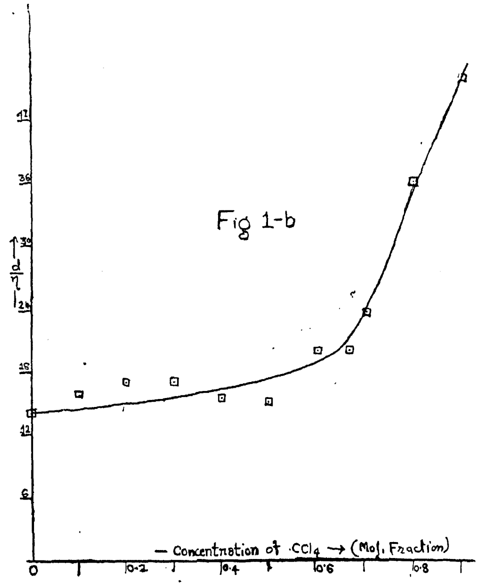
It was, therefore, considered worthwhile to extend the study to benzylamine which is isomeric with toluidines but is aliphatic in character. As benzylamine is miscible with water in all proportions, the observations were extended to water-benzylamine mixtures also.

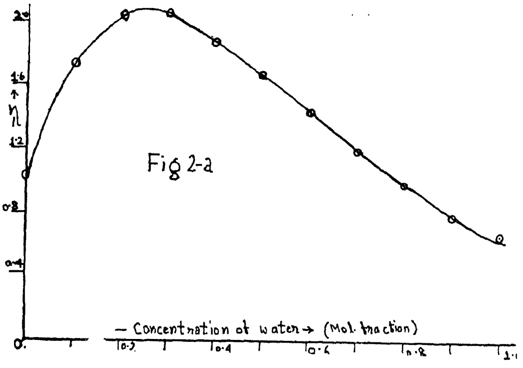
The experimental technique used was the same as reported in our earlier communications[1,2]. The CS_2 and CCl_4 were from B.D.H. and benzylamine was from Ward Blenkinsop, all of analar grade. They were all freshly distilled before use. The distilled water was also boiled before use to expel any dissolved oxygen.

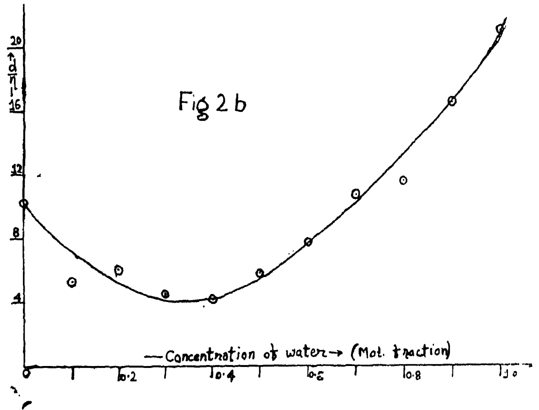
It was found that benzylamine reacted with CS_2 chemically giving a solid precipitate and hence could not be studied.



The results for the other two systems are shown graphically in Fig. 1 and Fig. 2 respectively. In these figures *d* denotes the maximum signal height corrected for the concentration of protons and η is the coefficient of viscosity of the liquid. d/η is found to increase with the concentration of CCl_4, and, on the lines of







our previous studies[1,2], this can be interpreted as indicating association between the benzylamine and carbontetrachloride molecules.

However, in the case of the water-benzylamine system, d/η first decreases as the proportion of water increases, becomes minimum at 40·4% concentration of water, and then increases. At the same time viscosity is found to increase as the proportion of water is increased, reaches a maximum at more or less the same concentration where the d/η curve reaches its minimum and then decreases. As these results are different from those obtained previously, further investigations in this regard are under way.

The authors wish to express their thanks to Prof. C. Mande and Prof. R. H. Sahasrabuddhe of the Nagpur University, for their help in the work and to the N.C.E.R.T., for the grant of a research scholarship to one of them (SVB).

Dept. of Physics, P. L. Khare.*
Nagpur University, S. V. Bhave.*
Nagpur, C. S. Adgaonkar.**
September 3, 1971. V. G. Kher.‡

---

* Dept. of Physics, Nagpur University, Nagpur.
** Dept. of Physics, V.M.V., Amravati.
‡ Dept. of Physics, Institution of Science, Nagpur.

1. Kher, V. G. and Modak, S. G., *Indian J. Pure appl. Phys.*, 1970, **8**, 409.
2. Modak, S. G., Khare, P. L., Mande, C. and Kher, V. G., *Ibid.*, 1971. **9**, 735.
3. Bhave, S. V., Adgaonkar, C. S. and Khare, P. L., *Ibid.* (communicated).

CHEMICAL EXAMINATION OF *MIMUSOPS HEXANDRA* (ROXB.): ISOLATION OF A NEW TRITERPENE KETONE (HEXANDRONE)

Mimusops hexandra belonging to the family Sapotaceae' is a large evergreen tree, widely distributed from Deccan peninsula, northwards upto upper Gangetic plain[1]. The root and bark of the tree are considered astringent and are given in infantile diarrhoea; they also retard the fermentation of toddy[2]. The leaves are used in poultice for tumours and seeds are used as tonic febrifuge and anthelmintic[2].

The mesocarp fruit and bark of *M. hexandra* have been investigated[3-4] for α-spinasterol, α-amyrin acetate, α-amyrin cinnamate and unidentified triterpenoids, $C_{30}H_{50}O_3$, m.p. 263–66°, $C_{30}H_{50}O_4$, m.p. 215–20° and an acid 280–85°.

The red coarse powder of the dried root was exhaustively extracted with hot benzene. The concentrated extract (7·5 g), after defatting with light petroleum, was chromatographed over alumina from which three compounds A, m.p. 186° (benzene: P.E.) (40–60°) (3 : 1); B, m.p. 273–74° (benzene : P.E. 1 : 1) and C, m.p. 136–37° were separated.

The compound B (2·48 g) was crystallised from chloroforma-acetone in colourless needles, m.p. 273–74°, $(\alpha)^{25°} + 2{\cdot}9°$. It gave positive colour tests for triterpenoid. With pyridine and acetic anhydride it formed an acetate, m.p. 298–300°, and benzoate, m.p. 294° with benzoyl chloride. The product B appeared to be taraxerol which was confirmed by mixed, m.p. determination of the compound B with an authentic sample of taraxerol.

The compound C (1·18 g), m.p. 136–37°, $(\alpha)_D^{30°} - 37°$ was identified to be β-sitosterol by direct comparison with authentic sample and through their mixed m.p. determination of acetyl and benzoyl derivatives.

The compounds B and C and their derivatives have analysed satisfactorily.

The compound A (2·8 g) was purified by chromatography over alumina using benzene-petroleum ether as eluant followed by repeated crystallisations from *n*-hexane in colourless form, m.p. 186° $(\alpha)_D^{25°} + 14{\cdot}5°$ It has been provisionally named as hexandrone. (Found: C, 84·78; H, 11·14; $C_{30}H_{48}O$ requires C, 84·89, H, 11·32%), 2, 4-dinitrophenylhydrazone, $C_{36}H_{52}O_4N_4$, m.p. 320° (decomp.); Oxime, $C_{30}H_{49}NO$, m.p. 197–98°, reduction (aluminium isopropoxide) $C_{30}H_{50}O$, m.p. 163°, ν_{max} 1109 cm^{-1} (Secondary alcohol). It gave a pink colouration with Liebermann-Burchard reagent and yellow with tetranitromethane.

An infra-red spectrum of hexandrone has been recorded with Perkin-Elmer model 137 instrument ($CHCl_3$). The spectrum contains a strong band at 1715 cm^{-1}, indicative of the presence of a ketone in a six-membered ring. The appearance of a sharp peak at 1630 cm^{-1} suggested the presence of an ethylenic double bond. It also contained a strong band at 1177 cm^{-1} characteristic of gem-dimethyl group. The interesting positions of sharp infra-red absorption bands at 1370, 1110 and 1000 cm^{-1} were also specific for C-methyl group and cyclohexane respectively. This compound is under further investigation.

One of the authors (S. S. M.) wishes to thank Dr. R. C. Srivastava for his interest and Dr. S. C. Kushwaha for I.R. Spectrum.

Dept. of Chemistry, S. S. Misra.
H.B. Technological Institute, R. S. Tewari.
Kanpur, India, *August* 30, 1971. Bhola Nath.

---

1. Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glossary of Indian Medicinal Plants*, C.S.I.R., New Delhi, 1956, p. 168.
2. *The Wealth of India*, C.S.I.R., New Delhi, 1962, **6**, 298.
3. Misra, G. and Mitra, C. R., *Phytochemistry*, 1965, **4**, 345.
4. —, *Ibid.*, 1966, **5**, 535.
5. Misra, S. S. and Tewari, R. S., *Curr. Sci.*, 1971, **40** (1), 11.

BENZOTHIAZOLYL GUANIDINES AS ANTIBACTERIALS

In view of the significant biological activities associated with the diguanides and guanidines as antitubercular[1,2], antibacterial[1,3], algaecidal[4], etc. it was thought worthwhile to extend the research in this line. In the present communication several N-ethyl-N′-(substituted)-benzothiazolyl-N″-alkyl guanidines have been synthesised by desulphurisation of corresponding thiocarbamides with yellow lead oxide in presence of alkyl amines.

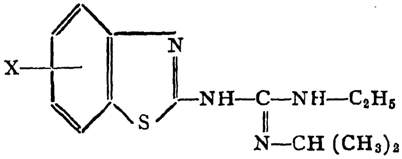
N-Ethyl-N′-2-(substituted)-benzothiazolyl thiocarbamides.—These were prepared by condensation of 2-amino-(substituted) benzothiazoles and ethyl isothiocyanate in the presence of dry benzene. The resulting product was washed with ether and dilute hydrochloric acid to remove unchanged reactants.

N-Ethyl-N′-2-(4-chloro)-benzothiazolyl-N″-isopropyl guanidines.—A mixture of N-ethyl-N′-2-(4-chloro)-benzothiazolyl thiocarbamide (2·7 g), yellow lead oxide (4·5 g), isopropyl amine (0·6 ml) in ethanol (20 ml) was heated in a sealed glass tube on a water-bath for 4 hours. After completion of the reaction the glass tube was opened carefully and the crude product filtered hot. The filtrate on cooling gave beautiful crystals. It was recrystallised from ethanol. Yield 60%, m.p. 202° C. Found: N, 18·62; S, 10·56 $C_{13}H_{17}ClN_4S$ requires N, 18·89; S, 10·79%).

Similarly, other N-ethyl-N′-2-(substituted)-benzothiazolyl-N″-isopropyl guanidines have

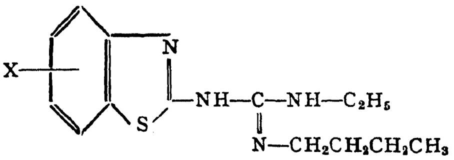
Table I

N-ethyl-N′-2-(substituted)-benzothiazolyl-N″-isopropyl guanidines



S. No.	Substituent		Yield %	M.P. °C.	Molecular formula	Nitrogen, %		Sulphur, %	
						Found	Calcd.	Found	Calcd.
1	4-Chloro	..	60	202	$C_{13}H_{17}SN_4Cl$	18·62	18·89	10·56	10·79
2	5-Chloro	..	65	186	$C_{13}H_{17}SN_4Cl$	19·19	18·89	10·42	10·79
3	4-Methyl	..	75	120	$C_{14}H_{20}N_4S$	20·00	20·29	11·32	11·60
4	5-Methyl	..	80	160	$C_{14}H_{20}N_4S$	20·52	20·29	11·38	11·60
5	6-Methyl	..	72	138	$C_{14}H_{20}N_4S$	20·49	20·29	11·41	11·60
6	4-Ethoxy	..	69	158	$C_{15}H_{22}N_4OS$	18·03	18·30	10·10	10·46

N-ethyl-N′-2-(substituted)-benzothiazolyl-N″-butyl guanidines



7	4-Chloro	..	77	194	$C_{14}H_{19}SN_4Cl$	17·72	18·03	9·99	10·30
8	5-Chloro	..	64	182	$C_{14}H_{19}SN_4Cl$	18·30	18·03	10·59	10·30
9	4-Methyl	..	72	134	$C_{15}H_{22}N_4S$	19·20	19·52	11·30	11·04
10	5-Methyl	..	80	168	$C_{15}H_{22}N_4S$	19·80	19·52	11·79	11·04
11	6-Methyl	..	89	142	$C_{15}H_{22}N_4S$	19·28	19·52	11·58	11·04
12	4-Ethoxy	..	85	152	$C_{16}H_{24}N_4SO$	17·19	17·50	9·78	10·00

been synthesised by the reaction of N-ethyl-N′-2-(substituted)-benzothiazolyl-thiocarbamide and isopropyl amine (Table I).

N-ethyl-N′-2-(substituted)-benzothiazolyl-N″-alkyl guanidines.—These guanidines have been synthesised by treatment of the corresponding thiocarbamides with different alkyl amines, instead of isopropyl amine, as usual (Table I).

Hydrochloride of N-ethyl-N′-2-(5-chloro)-benzothiazolyl-N″-butyl guanidine.—To the solution of N-ethyl-N′-2-(5-chloro)-benzothiazolyl-N″-butyl guanidine prepared in dry benzene, dry HCl gas was passed. The product was filtered and washed with dry ether thrice. It was crystallized from absolute ethanol. Yield 60%, m.p. 254° C.

Authors are thankful to the authorities of the Banaras Hindu University, for providing necessary facilities and financial assistance.

Department of Chemistry,
Faculty of Science,
Banaras Hindu University,
Varanasi-5, *August* 23, 1971.

P. N. Bhargava.
Fateh Bahadur.

---

1. Bhargava, P. N. and Lakhan, R., *Agri. Biol. Chem.*, 1968, **32**, 1392.
2. — and Chaurasia, M. R., *Curr. Sci.*, 1968, **37**, 347.
3. — and Choubey, V. N., *Agri. Biol. Chem.*, 1970, **34**, 644.
4. Singh, G. C., *J. Ind. Chem. Soc.*, 1968, **45**, 27.

EFFECT OF ESTROGEN ON TUBAL TRANSPORT OF OVA IN RATS FITTED WITH INTRAUTERINE CONTRACEPTIVE SUTURE

Transport of ova through the Fallopian tube of rats takes 4 days before they enter the uterus. Estrogens are known to interrupt pregnancy in this species when administered on day 1, 2 or 3 *post-coitum*[1-3]. Presence of a suture (IUCD) in the rat uterus has been reported to mimic or synergize some of the effects of estrogen[4-7]. Although it is now satisfactorily established that an IUCD does not normally influence the tubal transport of ova in rats[8], it has been considered worthwhile to explore if a sub-optimal dose of estrogen could synergize the effect of the device and accelerate ova passage in rats.

Colony-bred young adult rats (130–150 gm) of the Institute were fitted with a nylon suture in one uterine horn as described previously[4]; the contralateral horn served as the sham-operated control. The animals received post-operative antibiotic therapy for 3 days. Forty-five days after insertion of the suture the rats were mated to coeval males of proven fertility. The day on which the vaginal smears showed the presence of spermatozoa was considered day 1 of pregnancy.

In pilot tests with normal pregnant rats it was found that a single intramuscular injection of estrone (20 μg/rat) on day 1 of pregnancy caused cent per cent expulsion of ova from the tubes; 10 μg estrone was found to be ineffective. On this basis, groups of rats fitted with IUCD received either 10 or 20 μg estrone on day 1 of pregnancy and sacrificed 24 or 48 hr later; the ova collected from the Fallopian tube were examined under a phase contrast microscope.

It will be seen from the results presented in Table I that the presence of an IUCD had no effect on the tubal transport of ova. A single injection of estrone (10 μg/rat) on day 1 pregnancy also gave similar results. However, there was an acceleration of ova transport when the dose of estrogen was raised to 20 μg. This was evident only on day 3 of pregnancy, which was in contrast to the report of Banik and Pincus[1] who observed that this dose given on day 1 completely eliminated tubal ova within 24 hr. A strain difference in rats in response to estrogen was probably indicated. Microscopic examination of ova did not show any interference with fertilization or their development.

Table I

Effect of IUCD and estrogen on tubal transport of ova in rats

Treatment	Day of ova collection	
	Day 2	Day 3
No estrogen		
Control side	10 (3-4) *3*	11 (2-5) *4*
IUCD side	11 (2-5) *3*	10 (1-4) *4*
10 μg estrone		
Control side	11 (1-5) *4*	13 (1-4) *5*
IUCD side	12 (1-4) *4*	17 (2-4) *5*
20 μg estrone		
Control side	12 (1-4) *4*	0 (0-0) *6*
IUCD side	14 (1-5) *4*	0 (0-0) *6*

* Total No. of ova collected with range in parenthesis; Number of animals in italics.

It thus appears that IUCD has no effect on tubal transport, fertilization and development of ova in rats. Similarly, a sub-optimal or optimal dose of estrogen does not hasten the tubal passage of ova. Apparently, in this species an IUCD mimics only the uterine effects of estrogen and not those on the Fallopian tube.

This investigation was supported by grants from the Ministry of Health, Family Planning and Urban Development, Government of India

and the Ford Foundation. The authors are grateful to Dr. M. L. Dhar for his interest in this study, and Dr. V. P. Kamboj for valuable help.

Central Drug Research Institute, Amiya B. Kar.
Lucknow, *July* 30, 1971. B. S. Setty.
(Communication No. 1668).

---

1. Banik, U. K. and Pincus, G., *Proc. Soc. Exp. Biol. Med.*, 1964, **116**, 1032.
2. Saunders, F. J., and Rorig, K., *Fertil. Steril.*, 1964, **15**, **202**.
3. Greenwald, G. S., *Anst. Rec.*, 1967, **157**, 163.
4. Kar, A. B., Goswami, A., Kamboj, V. P, and Chowdhury, S. R., *Steroids*, 1964, **4**, **159**.
5. Stock, L., Ledger, W. J. and Campbell, C., *Fertil. Steril.*, **1968**, 19. **644**.
6. Joshi, S. G., *Contraception*, 1970, **2**, 137.
7. Malaviya, B., Karkun, J. N. and Kar, A. B., *Indian J. Exp. Biol.*, 1970, **8**, 19.
8. Kar, A. B., *J. Sci. Indust. Res.*, 1968, **27**, 70.

CAPILLARY CONDENSATION OF WATER IN PROTEINS

There is no general agreement about the manner in which the water of hydration is held by the proteins. It is, however, widely accepted that proteins sorb[1-3] water vapour by binding water molecules to specific hydrophilic sites at low relative vapour pressures followed by multimolecular adsorption or condensation in capillaries as the relative humidity approaches unity. Recently we studied[4,5] the water vapour sorption-desorption hysteresis on gelatin, egg albumin and casein and explained the results by speculating the existence of pores in proteins. It is the purpose of this communication to present an evidence of capillary condensation of water taking place in these proteins.

Contribution due to capillary condensation in small pores and to adsorption on the free surface has been separated by use of an equation suggested independently by Frenkel[6], Halsey[7] and Hill[8] and is generally known as FHH equation. This equation has the form

$$\log \log (po/p) = r \log \theta$$

where θ corresponds to the fraction of surface coverage or any variable proportional to it such as amount adsorbed.

Water vapour sorption data of first isotherm of gelatin, egg albumin and casein in each case from the earlier publication[5] were plotted in Fig. 1 according to the FHH equation which gave curved plots.

It has been demonstrated by Pierce[9] that deviation from a linear FHH plot indicates that capillary condensation is occurring. He has further shown[10] that FHH plot may be used to detect small capillaries by showing a curved rather than straight line or straight line of too low a slope. These results conclude that capillary condensation is taking place in very fine pores of proteins.

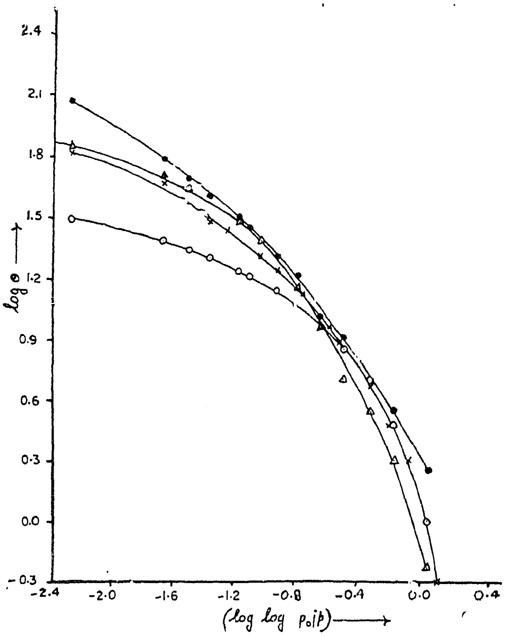


FIG. 1. FHH plots of water isotherms for Difco-geletin (△), Oxoid geletin (×), Egg albumin (●), and Casein (⊙).

The author is thankful to Dr. I. S. Bhatia, Professor and Head, Department of Chemistry and Biochemistry, Punjab Agricultural University, Ludhiana, for encouragement.

Chemistry and Biochemistry Department, Bhagwan Das.
Punjab Agricultural University,
Ludhiana, *August* 2, 1971.

---

1. Bull, H. B., *J. Am. Chem. Soc.*, 1944, **66**, **1499**.
2. Pauling, L., *Ibid.*, 1945, **67**, 555.
3. MeLaren, A. D and Rowen, J. W., *J. Polm. Sci.*, 1951, **7**, 289.
4. Subba Rao, K. and Das, B., *Curr. Sci.*, **1967**, **36**, 657.
5. —, *J. Phys. Chem.*, 1968, **72**, 1223.
6. Frenkel, J., *Kinetic Theory of Liquids*, Oxford University Press, London, 1946.
7. Halsey, G. Jr. *J. Chem.*, *Phys.*, 1948, **16**, 931.
8. Hill, T. L., *Advan. Catal.*, 1952. **4**, 212.
9. Pierce, C., *J. Phys. Chem.*, 1959, **63**, 1076; **1960**, **64**, 1184.
10. Pierce, C and Ewing, B., *J. Am. Chem. Soc.*, **1962**, **84**, 4070.

NEW TRANSFERRIN TYPE (S) IN SHEEP

TRANSFERRIN polymorphism in sheep was first reported by Ashton (1958, *a*, *b*) who observed five transferrin alleles Tf A, B, C, D and Tf E, in British breeds of sheep. Ashton *et al.* (1963) later reported five more transferrin alleles, Tf F, G, H, J, and Tf K in non-British breeds. Since then a total of 14 different transferrin alleles have been reported in sheep (Ashton and Dougall, 1958; Khattab *et al.*, 1964; Efremov and Braend, 1965; Cooper, 1966; King and Fechter, 1966; Fesus, 1967). On the basis of sheep transferrin standardisation trial held in 1966 by the Europen Society for Animal Blood Group Research, Oosterlee and Bouw (1967), however, have recommended that only nine transferrin alleles be recognised and these have been designated Tf I, A, G, B, C, M, D, E and P according to their decreasing electrophoretic mobility on starch gel. Similar studies on transferrins in Indian breeds of sheep, *viz.*, Nali, Lohi, Mandya and Nellore have shown that the most commonly occurring transferrin types in these breeds are Tf B, C, M, and Tf D (Arora, 1970).

The present communication describes the occurrence of new transferrin type (s) which were obtained in one individual of the Nali breed during an extensive study of transferrin polymorphism in four Indian breeds of sheep and their crosses. The serum sample from this individual denoted as Exptl. in comparison to standard (Std.) (Fig. 1) was run along the standard serum got from Dr. Bouw of Copenhagen Laboratories, Wegeningen, Netherland.

Soluble starch was hydrolysed and the gel was prepared according to "Kristjansson" (1963). Twelve and half per cent hydrolysed starch was used to give a 2 mm thick gel which after staining facilitated clear identification of bands without cutting. Tris-citrate (pH 7·6) was used as the gel buffer and borate buffer (pH 8·6) as the electrolyte.

The starch gel electrophoretic separation of the new transferrin type (s) in the serum of individual under study (Exptl.) is shown in Fig. 1. This figure also shows for comparison the separation of standard serum (std.) positive for P and D transferrin types (*i.e.*, a heterozygote), P—being the slowest moving transferrin reported so far. The standard serum sample also shows two faint bands one of which corresponds to Tf E. The serum of the animal under study shows three distinct transferrin bands, two of which have electrophoretic mobility slower than Tf P of the standard serum and the third band corresponding to Tf D. This indicates that the animal is heterozygous for the transferrin alleles Tf E and the new transferrin type (s).

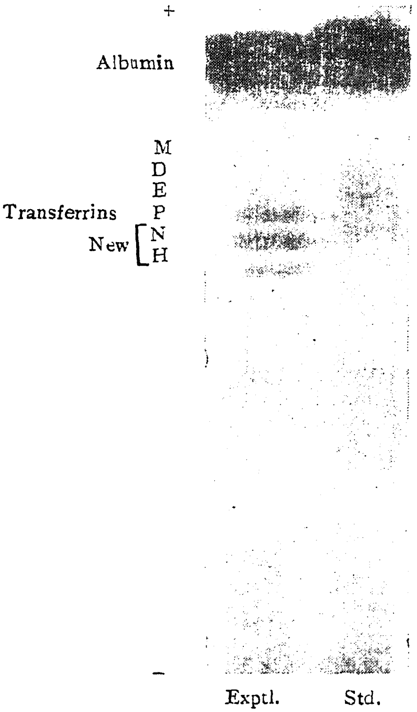


FIG. 1. Starch gel electrophoretic pattern showing the relative positions of new transferrin type (s) along with the Standard. *Tris*-citrate (pH 7·6) was employed as the gel buffer.

The individual under study was born to a dam heterozygous for P and E transferrin alleles but the genotype of the sire is not known. Consequently, it must have inherited the E allele from its mother and new transferrin allele from its father. Since the animal under study was anaemic, it died and this has prevented any further genetic and biochemical investigations.

Ordinarily each transferrin allele expresses two bands when subjected to starch gel electrophoresis, one staining deeply (which is comparatively slow moving), and the other staining faintly (of standard serum in Fig. 1). In the case of the individual under reference, the E allele is expressed normally but the new transferrin allele (s) forms two bands which are deeply staining and the one which stains comparatively lightly has a slower mobility, thus representing a deviation from the normal situation. Whether the two new transferrin types, which have the electrophoretic mobilities slower than that of the transferrin types reported so far, represent expression of a single allele or two alleles cannot be ascertained. Since the new transferrin type (s) do not occur normally in the Nali breed, these must perhaps be the consequence of some gene mutation and may be related to the anaemic state of the animal just similar to a situation of Haemoglobin C or may be case of intracistronic duplication. Of the two new transferrin bands, we have designated the slowest moving band as Tf H and the second one as Tf N.

The authors wish to express their thanks to Dr. Bouw and Dr. Oosterlee of Copenhagen Laboratories, Wegeningen, for supplying the sheep reference sera. Senior author's thank are also due to Indian Council of Agricultural Research, for the provision of financial help in the form of Senior Fellowship during the course of this study.

Haryana Agri. Univ., C. L. ARORA.*
Hissar, R. M. ACHARYA.*
Haryana (India), S. N. KAKAR.
August 2, 1971.

---

* Present address : Central Sheep & Wool Research Institute, P.O. Avikanagar, *Via* : Jaipur (Rajasthan).

1. Ashton, G. C., *Nature*, 1958 *a*, **181**, **849**.
2. —, *Ibid.*, 1958 *b*, **182**, **1101**.
3. — and Ferguson, K. A., *Genet. Res.*, **1963**, **4**, **240**.
4. — and M. C. Dougall, E. L., *Nature*, **1958**, **182**, **945**.
5. Khattab, A.G.H., Waston, J. H. and Axford, R.A.E., *Anim. Prod.*, 1964, **6**, 207.
6. Effremov, G., Braend, M., *Proc. 9th Europe Anim. Blood Group Conf.*, 1965, p. 313.
7. Cooper, D. W., *Proc. 10th Europe Conf. Anim Blood Group and Biochem. Polymorph.*, 1966, p 301.
8. King, P. and Fechter. H., "Transferrin Polymorphism in South African Sheep." *Ibid.*, 1966, p 307.
9. Fesus, L. "A new sheep transferrin allele Tf 1," *Acta. Vet. Hung.*, 1967, **17**, **95**.
10. Oosterlee, C. C. and Bouw, J., *Nomenclature of Transferrin Type in Sheep. Immunogenetic Letter*, 1967, **5**, 10.
11. Arora, C. L., *Ph. D. Dissertation Submitted to Haryana Agricultural University*, 1970.
12. Kristjansson, F. K., *Genetic Control of Prealbumine in Pig. Genetics*, 1963, **48**, **1059**.

LOW CATION EXCHANGE CAPACITY OF ROOTS OF THE ROOT-PARASITE *SANTALUM ALBUM* L.

THOUGH man was aware of parasitism among the angiosperms since long ago, his understanding of the phenomenon has been rather slow. In fact as Ozenda[1] and Kuijt[2] have pointed out, investigations on this interesting group of plants are still in the exploratory stage and that not even the causes and physiological aspects of semi-root parasitism have yet been completely understood.

Santalum album L., commonly called sandalwood or sandal plant, is a semi-root parasite[3] on other plants with no particular specificity for hosts. Haustoria are produced on sandal roots and they establish parasitic union with roots of host plants with which they come in contact. Transfer of nutrients then takes place through vascular connections that are formed. For its survival, sandal has to successfully parasitize other plants within a few months after the germination of the seed ; thereafter it continues to be dependent on the host plants throughout its entire life span of 40–60 years.

Our knowledge of parasitism has not reached a stage wherefrom we can seek information either on the various materials which get transferred from the host to the parasite or the actual mode of their transfer. However, with the help of radioisotopes, movement of some organic compounds and of minerals like phosphorus and calcium have been followed in certain other root parasites like *Melampyrum lineare*[4], *Odontites verna*[5,6], *Striga asiatica*[7] and *Striga senegalensis*[8,9].

The uptake of nutrients by plants from the soil involves their initial absorption on the roots, cation exchange capacity (CEC) of the roots by influencing the activity and movement of ions in the vicinity of the sites of active absorption, affects uptake of nutrients[10]. Though Ando[11] has suggested that CEC of roots may not be related to nutrient uptake, there are numerous other reports demonstrating that the ability of the plants to take up cations from the soil is largely dependent upon the CEC of the plant roots and valence of the cation.

Movement of nutrients from root to parasite and uptake of nutrients and CEC of *Santalum* and its experimental host *Dolichos lablab* were investigated. The observations made on the CEC of the roots of these plants are reported here.

Seedlings of *S. album* and *D. lablab*, 4–6 months old, were carefully uprooted from the

ots kept in the green-house in such a manner
hat the root tips were intact and free of injury.
hoots were clipped off and the roots were
ashed several times in running water. CEC
f the roots was then determined according to
ne method of Crooke[19] which comprises of
ashing the roots in distilled water and char-
ng them with 0·01 N HCl. The absorbed H^+
ns are then released in 1·0 N KCl solution
nd titrated immediately against 0·01 N KOH
lution to pH 7. Titre values denote CEC
nd are reported as milliequivalents (m.e.)
er 100 g of dry roots.

The results (Table I) clearly showed that
e cation exchange capacity of *Santalum* roots
as very low in comparison to its experimental
st *Dolichos*. The CEC of four other perennial
ants which could serve as host for *Santalum*
as also determined. The results revealed
at CEC of sandal is low even when compared
other perennial plants (Table I). This
rhaps explains one reason for its parasitic
bit.

TABLE I

Cation exchange capacity of roots of sandal and its host plants

Plant		m.e./100 g*
Santalum	..	7
Eucalyptus sp.	..	22
Peltophorum sp.	..	34
Delonix sp.	..	28
Tamarindus sp.	..	52
Dolichos sp.	..	44

* Mean of 4–6 plants.

When one considers that CEC is definitely
rrelated to rate of cation uptake[8-18] the
t that the sandal is a parasite with roots of
w exchange capacity assumes physiological
nificance. In order to know what happens
the CEC on parasitization, sandal and
lichos plants were grown in the same pots.
ter 3 months both the plants were removed
d washed as described earlier. All the haus-
ial connections were severed and the two
nts were separated. The CEC was deter-
ned for parasitized sandal and host roots
before.

In the case of *Dolichos* there was no
ference between CEC of parasitized and
parasitized plants, whereas in sandal there
s a significant increase in the CEC of roots
parasitized plants (Table II). The exchange
pacity of roots is governed by the external
vironment and the metabolic activity of the
nts. Parasitization renders the plant more vigorous and healthy and results in increased exchange capacity of their roots.

TABLE II

Cation exchange capacity of roots of parasitized and unparasitized plants

Plant		CEC me../100 g*
Santalum (Unparasitized)	..	7
Santalum (Parasitized)	..	13†
Dolichos (Unparasitized)	..	44
Dolichos (Parasitized)	..	41

* Mean of 4–6 plants; † Significant at 1% level.

Mrs. Kunda Deval is thankful to the Council of Scientific and Industrial Research, New Delhi, for the award of a Research Fellowship.

Microbiology and Pharmacology Laboratory,
Indian Institute of Science,
Bangalore-12, *August* 13, 1971.

KUNDA DEVAL.
V. N. VASANTHRAJAN.
J. V. BHAT.

---

1. Ozenda, P., *Phytomorphology*, 1965, **15**, 311.
2. Kuijt, J., *The Biology of Parasitic Flowering Plants*, Univ California Press, **1969**.
3. Barber, C. A., *Mem. Dept, Agric, India, Bot. Sect.*, **1906**, **1**, 1.
4. Cantlon, J. E., Curtis, E. J. C. and Malcolm, W. M., *Ecology*, 1963, **44**, 466.
5. Govier, R. N., Nelson, M. D. and Pate, J. S., *New Phytol.*, 1967, **66**, 285.
6. —, Brown, J. G. S. and Pate, J. S., *Ibid.*, 1968, **67**, 963.
7. Rogers, W. E. and Nelson, R. R., *Phytopath.*, 1962, **52**, 1064.
8. Okonkwo, S. N. C., *Amer. J. Bot.*, 1966, **53**, 142.
9. —, *Phytomorph.*, 1967, **16**, 453.
10. Wiersum, L. K. and Bakema, K., *Plant Soil*, 1969, **11** 287.
11. Ando, T., *J. Fac. Fish. Anim. Husb.*, Hiroshima Univ., 1970, **9**, 83.
12. Wiklander, L. and Elgabaly, H. M., *Soil Sci.*, 1956, **80**, 91.
13. Elgabaly, H. M. and Wiklander, L., *Ibid.*, 1949, **67**, 419.
14. Drake, M., Vengris, J. and Colby, W. G., *Ibid.*, 1951, **72**, 139.
15. Smith, R. L., and Wallace, C. E. A., *Ibid.*, 1956, **82**, 165.
16. Mclean, E. G., Adams, D. and Franklin, Jr., R. E., *Soil. Sci. Soc. Amer. Proc.*, 1956, **20**, 345.
17. Gray, B., Drake, M. and Colby, W. G., *Ibid.*, 1953, **17**, 235.
18. Helmy, A. K. and Elgabaly, H. M., *Plant Soil*, 1958, **10**, 78.
19. Crooke, W. M., *Soil Sci.*, 1958, **86**, 231.

Th/U RATIO AS AN AID IN PROSPECTING FOR DIAMONDS IN THE KIMBERLITIC ROCKS OF INDIA

GANGADHARAM and ASWATHANARAYANA[1] determined, by neutron activation analysis, thorium (av : 19·7 ppm) and uranium (av : 0·61 ppm) contents in the kimberlite diatremes of

Wajrakarur (15° 01′ N; 77° 23′ E) and Lattavaram (14° 55′ N; 77° 17′ E) and the kimberlitic dykes (with carbonatitic affinities) of Chelima (15° 27′ N; 78° 42′ E), all in Andhra Pradesh. They found consistently high Th/U ratios (range: 23 to 45; av: 32). That the high Th/U ratios may be the inherent feature of some Andhra Pradesh kimberlites and may not be due to the granitic xenoliths may be surmised from two observations (*i*) the Closepet granite and the Peninsular gneiss (which might have provided the granitic xenoliths in the Wajrakarur kimberlites) have Th/U ratios of 6·4 and 1·9 respectively[2] and (*ii*) the kimberlitic rocks emplaced in the Cumbum Phyllites are also characterised by high Th/U ratios. On the basis of detailed radiometric studies in the well-known diamond field of Yakutia, USSR, Akimov and Semenov[3] recently showed that (*i*) the kimberlites are generally more radioactive than the host rocks, (*ii*) there exists a relationship between the thorium and diamond contents of kimberlites and (*iii*) the diamondiferous kimberlites are characterised by low Th/U ratios of the order of 3 to 4, whereas kimberlites without diamonds are characterised by high Th/U ratios of the order of 15 to 20. The kimberlites of South Africa[4] which are known to be diamondiferous have Th: 11·2 ppm, U: 2·8 ppm, Th/U: 4, and hence do fit into the pattern delineated for Yakutia. These conclusions not only explain as to why those Andhra Pradesh kimberlites, which are currently being mined, have not been highly productive (in terms of number of carats per thousand tons of material processed), but also provides a powerful new tool for prospecting for diamonds in the kimberlitic rocks of Andhra Pradesh (the home of the fabulous diamonds of Golconda) and Madhya Pradesh. Gross radioactivity measurements for locating the kimberlitic areas and Th/U ratio measurements for locating the diamondiferous zones in kimberlites, could be conveniently made by gamma-ray scintillation spectrometry. Helicopter surveys[5] (employing $5'' \times 5''$ sodium iodide, thallium activated crystal; 25 mph speed; determination of Th from Tl^{208} peak at 2·42–2·62 Mev; determination of U from Bi^{214} peak at 1·65–1·88 Mev) and *in situ* ground[6,7] and mine surveys for Th, U and K using a three channel portable gamma-ray scintillation spectrometer (which costs about Rs. 20,000 to build) could be employed for the purpose.

Centre of Advanced Study in Geology,
University of Saugar,
Sagar, M.P., *August* 26, 1971.

U. ASWATHANARAYANA.

---

1. Gangadharam, E. V. and Aswathanarayana, U., *Trans. Amer. Geophy. Uni.*, 1969, **50** (4), **341**.
2. Divakararao, V., Aswathanarayana, U. and Qureshy, M. N., *Mineralog. Mag.*, 1971 (in Press).
3. Akimov, A. P. and Semenov, G. S., *Doklady Akad. Nauk, USSR*, 1970, **190** (4), 947.
4. Lovering, J. F. and Tatsumoto, M., *Earth and Planetary Sci. lett.*, 1968, **4**, 350.
5. Darnley, A. G., Bristow, Q. and Donhoffer, D. K., in *Nuclear Techniques and Mineral Resources*, Int. Atom. Energy Agency, Vienna, 1969, **7**, p. 163.
6. Killeen, P. G. and Carmichael, C. M., *Can. J. Earth Sci.*, 1970, **7**, 1093.
7. Lovborg, L., Wollenberg, H., Sorensen, P. and Hansen J., *Econ. Geol.*, 1971, **66**, 363.

CHANGES IN THE ACTIVITY OF CYTOCHROME OXIDASE DURING ADAPTATION OF EARTHWORM *LAMPITO MAURITII* TO DIFFERENT TEMPERATURES

INFORMATION concerning the changes in the activity of cytochrome oxidase on thermal acclimation is scant. Freed[1] found increased cytochrome oxidase activity in goldfish muscle on cold acclimation. Bishop and Gordon[2] reported that adaptation temperature has no effect on cytochrome oxidase activity. Working with *Lampito mauritii* Saroja and Rao[3] reported that cytochrome activity increases on cold adaptation. Nayeemunnisa[4] working with the same animal reported increase in lipase activity on cold acclimation. The present study was undertaken to see if similar changes in the same direction occur in the cytochrome oxidase activity also. It is anticipated that the study would yield interesting results toward proper understanding of the cellular mechanisms that underlie thermal compensation.

Earthworms, *Lampito mauritii*, were collected in the same locality and kept in the laboratory in glass troughs immersed in tap-water. The troughs were covered with wire sieves to prevent the escape of the worms. For the experimental acclimation worms were kept at the cold (20° C), warm (35° C) and normal (28 ± 1° C) temperatures for more than 15 days to get them completely acclimated to the respective temperatures. Body fluids of normal cold and warm acclimated worms were utilised for analysis. These were extracted from the worms by cutting the worm into pieces in a fine sieve mesh and the fluid was squeezed out from the bits by hand pressing into an embryo cup.

Cytochrome oxidase activity was followed by the colorimetric method of Oda *et al.*[5] utilizing fresh body fluids of acclimated and control worms.

TABLE I

Changes in the activity of cytochrome oxidase following thermal acclimation in Lampito mauritii

Group	Mg. Neotetrazolium chloride/100 ml/hour	't'
Cold acclimated ..	26·86 ± 5·1 (8)	5·62* $p = 0\cdot001$
Controls (normal) ..	15·09 ± 2·9 (9)	5·20† $p = 0\cdot001$
Warm acclimated ..	14·83 ± 3·0 (9)	0·18‡ Not significant

Values are mean ± S.D.

Number in parenthesis indicates number of observations. * Between cold and warm, † Between cold and normal, ‡ Between controls and warm.

The data presented in Table I illustrates that the cytochrome oxidase activity is significantly high on cold acclimation compared to that of warm acclimated and control animals. On warm acclimation the activity showed significant decrease compared to that of cold acclimated animals. The per cent increase of activity in cold worms over controls is 78·1 and the per cent decrease on warm acclimation over controls is 2. The per cent decrease of activity in 'warm' worms over cold acclimated animals is 49·2. The levels of significance (t value) between normal and cold, and that between cold and warm are 5·62 and 5·20 respectively. The values are significant at 1% level. Such changes in the activity of cytochrome oxidase can be correlated to the changes in the activity of electron transport system. The compensatory increase in the cytochrome oxidase activity on acclimation to low temperature may indicate higher activity of the electron transport system on acclimation to decreasing temperature. These changes in enzyme activity may indicate shifts in metabolic pathways.

The author is grateful to Prof. K. Pampapathi Rao, Head of the Department of Zoology, Bangalore University, for critically going through the manuscript and for offering facilities.

Department of Zoology, NAYEEMUNNISA.
Bangalore University,
Bangalore-1, South India,
August 14, 1971.

---

1. Freed, J., *Comp. Biochem. Physiol.*, 1965, **14**, 661.
2. Bishop, G. Lewis and Malcolm, S. Gordon, *Molecular Mechanisms of Temperature Adaptation*, A.A.A.S., Washington, D.C., 1967, p. 263.
3. Saroja, K. and Rao, K. P., *Z. Vergleich. Physiol.*, 1965, **50**, 35.
4. Nayeemunnisa, *Lipid Metabolism in Relation to Thermal Acclimation in Earthworms*, Ph.D. Thesis, Sri Venkateswara University, Tirupathi, A.P., India, 1966.
5. Oda, T., Seki, S. and Okajaki, H., *Acta. Med. Okayama*, 1958, **12**, 293.

A METHOD FOR ISOLATING PURE CULTURES OF THE INFECTIVE STAGE JUVENILES OF *BUNOSTOMUM TRIGONOCEPHALUM*

IN spite of rigorous precautions it was not uncommon for "Donor" lambs and kids experimentally infected with *Bunostomum trigonocephalum* (Rudolphi, 1808) to pick up light infection of *Strongyloides papillosus* (Weld, 1856) and we were beset with the difficulty of eliminating the juveniles and the free-living stages of the latter from faecal cultures. We have used with advantage the following method to obtain a pure isolate of *B. trigonocephalum* juveniles.

The faecal samples from lambs experimentally infected with *B. trigonocephalum* and having concomitant infection of *S. papillosus* were cultured following the method of Anantaraman[1] and incubated at a constant temperature of 30° C and relative humidity of 70–100%. The water in the outer jacket, to which infective juveniles migrate, was removed daily and replaced with fresh water. The juveniles were identified and the number occurring daily was counted by the dilution method.

The juveniles of *S. papillosus* formed much earlier and in larger numbers than the juveniles of *B. trigonocephalum*. On the first three days only the infective juveniles of *S. papillosus* were present (Table I). On the fourth day of incubation, both types of juveniles were present in the proportion of 1 : 1 to 1 : 1·9 (Table I). After seven days of incubation only the juveniles of *B. trigonocephalum* were present. The maximum number of juveniles of *B. trigonocephalum* were present on the 6th day but there was a liberal admixture with the juveniles of *S. papillosus*. On the 8th day of incubation the water jacket of the culture apparatus provided a pure culture of *B. trigonocephalum* juveniles.

TABLE I

Showing the ratio of the output of the infective juveniles of Bunostomum trigonocephalum *and* S. papillosus *from the culture apparatus incubated at 30° C and in a relative humidity of 70–100%*

No of days incubated	Ratio of *B. trigonocephalum* to *S. papillosus* juveniles in five sample cultures				
	1	2	3	4	5
1	..	..	..	..	..
2	..	..	..	..	..
3	0 : 1	0 : 1	0 : 1	0 : 1	0 : 1
4	1 : 1·5	1 : 1	1 : 1·9	1 : 1	1 : 1·6
5	1 : 1·2	1 : 0·8	1 : 1·1	1 : 1·2	1 : 1·1
6	1 : 0·6	1 : 0·1	1 : 0·13	1 : 1·3	1 : 0·1
7	1 : 0	1 : 0	1 : 0·06	1 : 0·18	1 : 0
8	1 : 0	1 : 0	1 : 0	1 : 0	1 : 0
9	1 : 0	1 : 0	1 : 0	1 : 0	1 : 0
10	1 : 0	1 : 0	1 : 0	1 : 0	1 : 0
11	1 : 0	1 : 0	1 : 0	1 : 0	1 : 0

The optimum development of the juveniles of *B. trigonocephalum* in four days at 29–30° C has been reported by Sarimsakov[2] and Belle[3] but we found that the development of some juvenile is much slower and this enabled us to obtain a pure culture by daily harvesting of the juveniles.

Division of Parasitology,
Indian Veterinary
Research Institute,
Izatnagar, Bareilly (U.P.),
August 4, 1971.

V. K. SRIVASTAVA.
G. SUBRAMANIAN.

---

1. Anantaraman, M., *Ind. J. vet. Sci.*, 1942, **12**, 87.
2. Sarimsakov, F. S., *Shornik Nauchnik Trudoy Uzbekskoi Akad. Selskhozyias-tyeniikh Nauk*, 1959, **13**, 112.
3. Belle, E. A., *Can. J. Zool.*, 1959, **37**, 289.

ASPERGILLUS FLAVUS LINK. —A FUNGAL PARASITE OF *EPILACHNA VIGINTIOCTOPUNCTATA* F.

FUNGI imperfecti have Entomophagous members like *Aspergillus flavus* L. A wide range of insects are susceptible to *Aspergillus flavus* L.[4,5] The pathogenic action is considered to be entirely due to the toxic action of the fungus[1,3,5]. Importance of toxins produced by *A. flavus* are also recognised in the fields of Veterinary Science and Medicine[2].

Working on the insect pest *Epilachna vigintioctopunctata* F., it was found that *A. flavus* was parasitising and controlling the populations of the insect in the egg, larval, pupal and adult stages. The spores of the fungus when sprayed on the insects on infested leaves killed them in three days. Crude toxin of *A. flavus* obtained by growing the fungus *in vitro* (in Richard's liquid nutritive medium) was sprayed on larvae of *E. vigintioctopunctata*, while on fresh brinjal leaves. The larvae in the control sprayed with autoclaved Richard's medium alone, grew normally and pupated with a low mortality, while the toxin treated ones stopped feeding, showed tetanic reactions and subsequently died (Table I).

TABLE I

Ten 12-day old larvae were used in each test

Period of exposure to toxin in days	Average number of larvae dead when sprayed with the crude toxin							Remarks
	Days							
	0	3	5	7	9	11	13	
1	..	..	..	..	..	..	0·5	Neat Richard's medium
2	0·5	..	1·0	1·5	1·5	2·5	3·5	Richard's medium + toxin
3	0·5	2·0	2·0	5·5	6·5	6·5	7·0	
4	0·5	2·0	4·5	7·5	7·5	7·5	9·0	
5	2·5	2·0	5·0	8·0	8·0	9·5	10·0	
6	2·5	2·0	5·5	8·0	8·0	9·5	10·0	
7	2·5	2·0	7·0	9·0	9·0	9·5	10·0	

Maximum kill is obtained from the culture filtrate incubated for 13 days, while culture filtrates incubated from 5 days to 11 days gave a kill ranging from 70% to 95%.

Spraying the larvae with spore suspensions of *A. flavus* did not bring out an immediate knock down of the larvae as was noticed in the case of spraying with the crude toxin (Table II).

TABLE II

Nine larvae were used in each test

Replication	Number of larvæ dead in hours				
	24	48	72	96	120
1	..	3	9	9	Fungal spores seen on insect
2	..	3	6	9	
3	..	3	6	9	
4	..	3	9	9	

Thus, while the crude toxic filtrate of *A. flavus* has a good knock down effect on the insect, the spores not only kill the insect, but also help in dispersal of the fungus in the field. It would seem that a combination of the crude toxin and the spores may prove to be more effective in the field for the control of *Epilachna vigintioctopunctata* F., as an integrated control measure.

The authors are grateful to the Indian Council of Agricultural Research for the sanction of the Retired Scientist's Scheme under

ich this was done. They are also grateful the Principal, S.V. Agricultural College, G. H. Sankara Reddi, for the facilities vided. Thanks are also due to Dr. J. bbayya, Head of Pathology Division of the llege, for helpful suggestions.

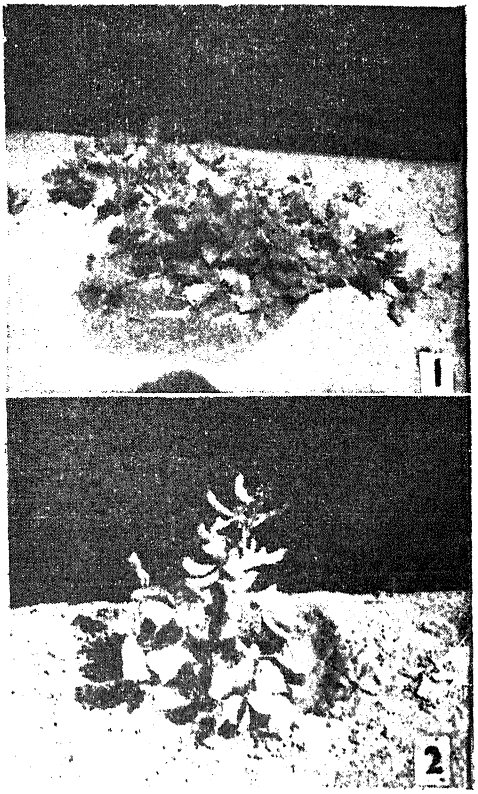
tomology Research C. KRISHNAMOORTHY.
aboratories, M. SANKAR NAIDU.
. Agricultural College,
upati, *August* 14, 1971.

Burnside, C. E , *U. S. Dept. Agr. Tech. Bull.*, 1930, **149**, 43.
Carnaghan, R. B. A., *Proc. Roy. Soc. Medicine*, 1963, **57**, 414.
Kodaira, Y., *J. Fac. Textile Sericult. Shinshu Univ. Ser E.*, 1961, **5**, 1.
Toumanoff, C., *Scient. Report*, 1928, **1**, 74.
——, *Ann. Parasitol. Humaine Comparee*, 1931, **11**, 129.

N ON-SEASON BOUND *DOLICHOS* *B-LAB* L. WITH NEW PLANT TYPE

DUCTIVITY of a crop mainly depends on 'plant '. Hence the prime objective in the plant ding programme of any crop is to get the rable plant architecture which maximises production per unit area in unit time. ess has been achieved in boosting up the uction through the development of varieties ideal plant type in case of major cereals wheat and paddy. Short stature and erect s in them have increased their photo- etic efficiency and their response to appli- n of high doses of fertilizers[1,2]. Further, levelopment of non-season bound types in crop makes it possible to grow all round ear under wider agro-climatic conditions. much work has been done previously in direction in case of pulse crops. This is ort on a segregant which is non-season with ideal plant type in *Dolichos lab-lab*, known as 'avare'.

chos lab-lab var. *lignosus* Prain is a ble *cum* pulse crop. It is a field type ated to a large extent in Mysore, Tamil and Andhra Pradesh. It has a spreading with tendrils, each plant occupying an f 3 to 4 sq ft. (Fig. 1). It blooms under day conditions of winter only. *Dolichos* var. *typicus* Prain is a perennial, minate, garden type, needs a mechanical t (pendal) and spreads over an area of sq ft. Hybridization was effected between neutral *Dolichos lab-lab* var. *typicus* type cally cultivated *Dolichos lab-lab* var. *lignosus*. The hybrid (F_1) is indeterminate, spreading type with tendrils and is a perennial.



FIGS. 1–2

A segregant was found in F_2 generation (breeding true even in F_6 generation) which resembled neither of the parents in habit. It is bushy, determinate in habit without tendrils (Fig. 2) which affords a possibility to accommodate more number of plants per unit area. Every branch of this plant ends up in an inflorescence, thus, much of the plant nutrients available are utilized for productive purpose resulting in higher yield of pods and seeds. It is early maturing, bears pods in 4 to 4½ months as against local *lignosus* type which needs 7 to 8 months for maturity. The pod fragrance commonly called as 'sogadu' or 'sone' which has got great consumers' preference is preponderant. Being a non-season bound type it opens a possibility of availability of this vegetable throughout the year.

The authors acknowledge the help from Prof. L. S. S. Kumar of ICAR's Retired Scientist's Scheme, University of Agricultural

Sciences, Hebbal, Bangalore, for his kind review of this note.

Department of
Agricultural Botany,
Univ. of Agri. Sci.,
Hebbal, Bangalore-24,
August 2, 1971.

S. R. Viswanatha.
G. Shivashankar.
A. Manjunath.

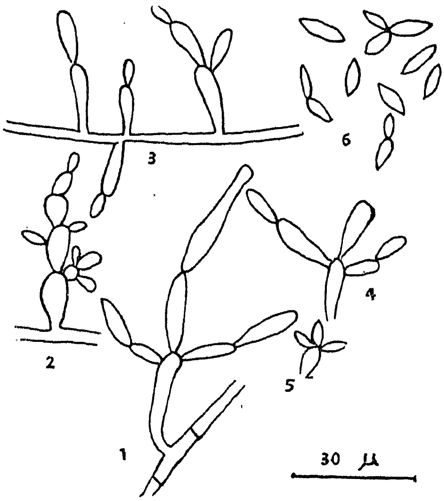
---

1. Jennings, P. R., *Crop Sci.*, 1969, **4**, 13.
2. Borlaug, N. E., *Proceedings of the Third International Wheat Genetics Symposium*, Australian Academy of Sciences, Canberra, 1968, p. 1.

A NEW SPECIES OF *HYALODENDRON* FROM INDIA

During the study of folicolous hyphomycetes of Jodhpur, the authors encountered an interesting species of *Hyalodendron* Diddens on the leaves of *Hibiscus rosa-sinensis* Linn. growing in Botanic Gardens, Jodhpur University, Jodhpur. The details of morphological characters showed that the present isolate is distinctly different from other known species[1] in having short claviform conidiophores and fusoid conidia. The conidial size is comparatively bigger than all known species. The isolate is, therefore, being disposed off as a new species.

Hyalodendron fusiforme sp. nov. (Figs. 1–6)



Figs. 1–6. Figs. 1-5. Conidiophores with sporogenous cells and conidia. Fig. 6. Conidia borne in simple and branched chains.

Colonies spreading with sparse aerial mycelium; hyphae branched, septate, 1·3–2·0 μ wide; conidiophores erect or decumbent, simple, unbranched, narrow at the base and broad at the apical portion, variable in length, 12·3–35·7 × 3·0–5·4 (average 24·5 × 4·1) μ; bearing sporogenous cells or conidia at the apical portion; conidia blastogenous, frequently in small clusters, becoming catenulate by acropetalous formation of new conidia, conidial chain dendrically branched, one-celled, hyaline, fusoid 8·2–13·6 × 2·7–4·0 (average 9·8 × 3·9) μ.

Isolated from the leaves of *Hibiscus rosa-sinensis* Linn. Culture deposited in C.M.I., Kew (C. No. 129298).

Hyalodendron fusiforme sp. nov.

Coloniae patulae, mycellio aerio sparse; hyphae ramosae, septatae, hyalinae, 1·3–2·0 μ diam; conidiophore erecta vel decumbenta, simplicia, aramosae, longitudine varia, 12·3–35·7 × 3·0–5·4 (media 24·5 × 4·1) μ, clavata, cellulae sporogenae vel conidia terminalia gerentia; conidia plerumque gregatum orta, origineu, conidiorum monorum acropetalum serius catenulata, conidiorum catenulis dendrioramosis, unicellularis, hyalina, fusoidea, 8·2–13·6 × 2·7–4·0 (media 9·8 × 3·9) μ.

Cultura in foliis *Hibiscus rosa-sinensis* Linn., India, S. M. Reddy et K. S. Bilgrami, IMI 129298 typus.

The authors are grateful to Drs. G. C. Ainsworth and M. B. Ellis of C.M.I., Kew, for sending the opinion on the culture, to Dr. Donald P. Rogers, Professor of Botany, University of Illinois, for Latin translation.

Department of Botany,
University of Jodhpur,
Jodhpur, India, *March* 31, 1971.

S. M. Reddy.*
K. S. Bilgrami.

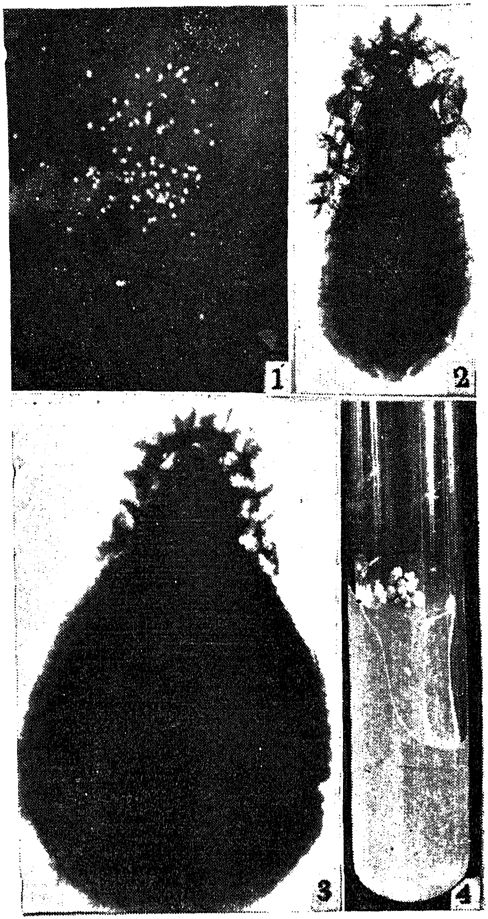
---

* Present Address: Botany Department, Osmania University Post-Graduate Centre, Warangal.

1. Ciccarone, A., *Annls. Inst. Phytopath*, Benaki, N. S., 1964, **6**, 27.

IN VITRO CULTURE OF THE SEEDS OF A ROOT PARASITE: *AEGINETIA INDICA* LINN.

In general it is believed that the germination of the seeds of parasites is difficult as they are dependent on some stimulants secreted by the hosts. However, in recent years considerable data has accumulated on the germination of such seeds without the association of hosts *in vitro*[1]. Rangan (1965)[2] obtained germination and callusing of the embryo in seed cultures of *Cistanche tubulosa* and the callus further differentiated shoots. In this communication the initiation of germination and the formation of callus from the *in vitro* grown seeds of *Aeginetia indica* Linn., a member of the Orobanchaceae are reported.



FIGS. 1-4. Fig. 1. Seeds at culture, × 3. Figs. 2-3. Wholemount preparations of germinating seeds from 2-week-old culture; note the intact seed coat, and the enormously swollen embryo in Fig. 3, ×130; 70. Fig. 4. A 6-week-old culture on BM + CM (10%) + kinetin (1 ppm) showing the callused embryos, × nat. size.

Aeginetia indica, a parasitic herb, grows apparently on the roots of many different plants. The mature capsules containing numerous, minute, pale yellow seeds (Fig. 1) were collected from the nearby forests and allowed to shed seeds in petri dishes. The sterilization of seeds was done similar to that in *Orobanche aegyptiaca*[3] either directly or after pre-soaking them for 24 hr in water or gibberellic acid (50 ppm). Then the seeds were transferred to agar nutrient media with a fine sterile scalpel. A modified Whites' medium containing mineral elements, glycine, vitamins and sucrose (2%) served as control (BM). Supplements like coconut milk (CM), IAA, NAA, 2, 4-D, kinetin and casein hydrolysate (CH) were added to BM before autoclaving. All cultures were maintained at controlled conditions of light, temperature and humidity.

At culture the seeds contained a starchy endosperm enclosing an undifferentiated embryo. The latter lacked the demarcation into the radicle, plumule and the cotyledons. On BM the seeds turned dark brown within a week after culture. They lay quiescent and failed to show any signs of germination even after 10 weeks of culture. Similar responses were noted in seeds sown on BM + CM (10%); BM + CM (10%) + IAA or NAA or kinetin (1 ppm each); BM + CH (1000 ppm) + kinetin (5 ppm) + 2, 4-D (2 ppm); and BM + CH (1000 ppm) + kinetin (2 ppm) + IAA (2 ppm).

However, good responses were obtained in pre-soaked seeds sown on BM supplemented with CM (10%) + kinetin (2 ppm) or both kinetin (2 ppm) and 2, 4-D (2 ppm). After a week of culture the seeds enlarged considerably. Subsequently the seed coats ruptured and the enlarging embryo emerged out after 2 weeks (Figs. 2, 3). In 6-week-old cultures the entire surface of the medium was filled with the germinating seeds. The radicle differentiated and occasionally developed into a root. The embryos, however, exhibited enormous swelling all over their surface. Many of them ruptured to yield a friable mass of yellowish tissue (Fig. 4). The microscopic examination of the embryos revealed that the callus originated from all over the surface. The callus comprised cells of diverse shapes and sizes. Thus with the use of *in vitro* culture technique the seeds of the parasitic angiosperms can be germinated without the association of the host.

Grateful acknowledgements are extended to the University Grants Commission, for the award of a Senior Research Fellowship to one of us (K. N.).

Dept. of Botany, M. S. CHENNAVEERAIAH.
Karnatak University, K. NATARAJA.
Dharwar-3, P. S. CHIKKANNAIAH.
Mysore State, August 16, 1971.

---

1. Johri, B. M. and Bhojwani, S. S., *Ann. Bot.*, 1970, **34**, 685.
2. Rangan, T. S., *Phytomorphology*, 1965, **15**, 180.
3. Rangaswamy, N. S., *In* Maheshwari, P. and Rangaswamy, N. S., *Plant Tissue and Organ Culture—A Symposium*, International Society of Plant Morphologists, Delhi University, 1963, p. 345.

PYRICULARIA ON BARLEY

DURING our survey of plant diseases in the winter months of 1969 and 1970 around Tirupati, we noted severe leaf spot on barley (*Hordeum vulgare* L.) and Italian millet (*Setaria italica* Beauv.) grown in the experimental farm of S.V. Agriculture College, and on ragi (*Eleusine coracana* Gaertn.), rice (*Oryza sativa* L.), bajra (*Pennisetum typhoides* Stapf and Hubb.) and *Arundo donax* L. in some other farms. Single spore isolates yielded Pyricularia. Infection of barley by *Pyricularia* has also been noticed at the Sugarcane Institute, Anakapalle, during February 1970 and the isolate has since been identified as *Pyricularia grisea* Sacc. at the CMI, Kew[1]. Presently, the isolate from barley has been compared with the other isolates of *Pyricularia* both from the point of view of spore morphology and infectivity.

When the isolate from barley was inoculated on leaves of barley plants minute yellow spots developed on the 3rd day. These yellow spots enlarged with time developing a browned centre. The spots eventually measured 2–3 cm long and 2–4 mm wide with 3 distinct zones—central pale brown necrotic area surrounded by a dark brown margin and an outermost chlorotic halo. Lesions develop on both young and old leaves. Lesions may coalesce to form large, irregular and elongated areas, accompanied by extensive yellowing of the leaves. The conidiophores and conidia develop on both surfaces of the lesion.

Conidiophores emerge through stomata or between epidermal cells in groups of 4 or 5, are pale brown, cylindrical, straight or slightly curved, 1 to 4 septate, geniculate, with blunt tips and bulbous bases, and measure 12·24–130·08 × 3·06–7·65 μ. Conidia are hyaline, obclavate, straight, mostly 3-celled, rarely 2-celled, with a narrow apex and a broad base and distinct hilum, and measure 12·24–32·13 × 7·65–10·71 μ.

TABLE I

Comparison of isolates of Pyricularia

		Conidia						Conidiophores		
		Length*		Width*		Septa		Length	Width	Septa
		H†	C	H	C	H	C	H	H	H
Hordeum vulgare	Max.	32·13	35·65	10·71	7·75	2	2	130·08	7·65	4
	Min.	12·24	12·4	7·65	6·2	1	1	12·24	3·06	1
Oryza sativa	Max.	31·00	35·65	9·3	9·3	2	2	232·5	6·2	3
	Min.	12·4	13·95	7·75	6·2	1	1	49·6	3·1	2
Setaria italica	Max.	31·00	31·00	9·3	9·3	2	2	150·1	4·65	3
	Min.	12·4	12·4	6·2	6·2	1	1	45·5	3·1	2
Eleusine coracana	Max.	27·9	34·1	7·75	7·75	2	2	124·00	6·2	4
	Min.	15·5	12·4	6·2	6·2	1	1	46·5	3·1	2
Pennisetum typhoides	Max.	31·00	38·85	9·3	7·75	2	2	139·5	6·2	4
	Min.	9·3	15·5	6·2	6·2	1	1	31·00	3·1	2
Arundo donax	Max.	29·45	..	9·3	..	2	..	124·00	6·2	3
	Min.	15·5	..	7·75	..	1	..	36·2	3·1	2

* In microns, † H—From sporulating leaf lesions, C—From sporulating potato-sucrose-agar cultures.

Table I gives details of spore measurements of the different isolates. Isolates from *A. donax* did not sporulate in culture. Conidiophores from rice leaves are the longest, while those from other hosts fall within a narrow range of 124 to 150 μ. In lesions the length of conidia of all the isolates fall within the range of 28 to 32 μ. The width of conidia from barley leaves is the greatest and those from *E. coracana* the smallest. In culture, conidia of barley, ragi and bajra isolates are similar in width, forming one group, and those of rice and *S. italica* are wider forming another group. These spore measurements fall within the range reported by Asuyama[2] for various, *Pyricularia* isolates.

At least 4 single spore isolates from each of the hosts were used in the pathogenicity tests. The night temperatures fluctuated between 15 and 25° C during these experiments. All the 4 varieties of barley—B.D. 27, piroline, N.P. 104 and N.P. 113—were highly susceptible to the barley isolates, which did not infect IR 8, TN 1 and GEB 24 cultivars of rice (*O. sativa*), *E. coracana*, *S. italica*, *P. typhoides*, *S. vulgare*, *T. vulgare* and *A. donax*. Isolates of *Pyricularia* from *E. coracana*, *S. italica*, *P. typhoides* and *A. donax* appeared to be specific to their respective hosts under the experimental conditions of the investigation. An isolate from rice was, however, infective to barley also.

We record our thanks to the Principal and colleagues of the College of Agriculture for their help.

Dept. of Botany, Y. R. SARMA.
S.V. University, M. V. NAYUDU.
Tirupati,
and
Dept. of Botany, S. SURYANARAYANAN.
University of Madras,
Madras, August 23, 1971.

---

1. Appalanarasiah, P. and Lakshmikantham, M. (Private communication).
2. Asuyama, H., *The Rice Blast Disease*, Johns Hopkins Press, 1963, p. 9.

OCCURRENCE OF *CERCOSPORA CITRULLINA* ON MUSKMELON

MUSKMELON, (*Cucumis melo* L.), an important popular fruit crop grown in Tamil Nadu, was found severely infected with a species of *Cercospora*. Serious damage was observed on *C. melo* and *C. callosus* (Rottl.) Cogn. at the Agricultural Experimental Farm, Annamalai University, during November–February, 1969–70. A brief description of the disease is given below :

Leaf spots mostly circular, slightly irregular, 1–3 mm in diameter, pale yellow to light brown, sometimes ash-coloured with well-defined, slightly raised light brown margins; fruiting amphigenous, chiefly epiphyllous; stromata prominent, light yellow consisting of a few cells.

Conidiophores usually in spreading fascicles of 5–8, very rarely in singles, light yellow to sub-hyaline, straight, slightly curved with 2–6 prominent geniculations, multiseptate, unbranched, 23–81 μ in length and 2–4 μ in width (Fig. 1). Conidia hyaline, acicular, straight or rarely curved, distinctly multiseptate with broad base and acute tip; 50–200 × 2–3 μ with 2–12 septa.

The morphological characteristics of the fungus seem to agree with *Cercospora citrullina* Cooke[1] and hence identified as *Cercospora citrullina*. Though the pathogen *C. citrullina* has been recorded on the leaves of a number of cucurbitaceous hosts in India[2,3] like *Trichosanthes anguina* L., *Bryonopsis lacinosa* L.[4], *Citrullus vulgaris* Schrad, *Momordica charantia* L., *Coccinia cordifolia* (L.) Cogn., *Cucurbita maxima* Duch. and *Sechium edule* (Jacq) Sw. this seems to be the first record of the pathogen on *Cucumis melo* and *C. callosus*.

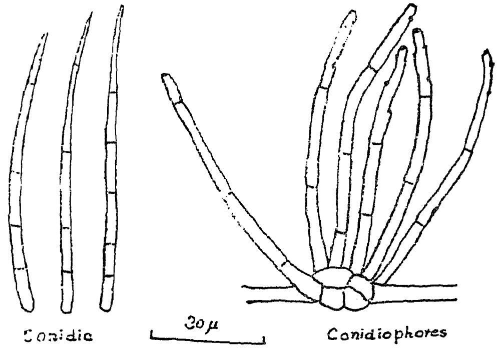


Fig. 1.

Type specimens have been deposited in the Herb. Crypt. Ind. Orient., Indian Agricultural Research Institute, New Delhi.

The authors record their sincere thanks to Dr. G. Rangaswami, Vice-Chancellor, Tamil Nadu Agricultural University, for his critical perusal of the paper. They are thankful to Dr. N. N. Prasad, and Dr. C. N. Sambandam for the encouragement and facilities provided.

Division of Microbiology, D. PURUSHOTHAMAN.
Faculty of Agriculture, V. RAGUNATHAN.
Annamalai University,
Annamalainagar (P.O.),
Tamil Nadu, India, *August* 10, 1971.

---

1. Chupp, C., *A Monograph of the Fungus Genus Cercospora*. Ithaca, New York, 1953, p. 609.
2. Ragunathan, V., Purushothaman, D. and Prasad, N. N., *Annamalai Univ. Agri Res. Annu.*, 1970, **21**, 1,
3. Rangaswami, G and Chandrasekaran, S., *Mycologia*, 1961, **53**, 371.
4. —, Seshadri, V. S and Lucy Chennamma, K. A., *Fungi of South India*, Univ. Agri. Sciences, Bangalore, 1970, p 195.
5. Rao, P. N, *Indian Phytopath*. 1965, **15**, 112.

REVIEWS AND NOTICES OF BOOKS

Physics of *p-n* Junctions and Semiconductor Devices. Edited by S. M. Ryvkin and Yu V. Shmartsev. (Consultants Bureau and Plenum Press Publication), Pp. ix + 366. Price $ 40.00.

This is a collection of 68 research papers on semiconductor physics, theory and applications, being the work done by Soviet scientists. The original Russian text was published in 1969 for the A. F. Joffe Physicotechnical Institute of the USSR Academy of Sciences. This corrected English translation of the special research report will be welcomed by all English-knowing scientists working in this growing field of research. A. S. G.

University Physics Series. Edited by Professor B. Donovan:

Group Theory in Solid-State Physics. By H. W. Streitwolf. 1971. Pp. 248. Price £ 5.00.

Electronic Energy Bands in Solids. By L. Pincherle. 1971. Pp. 196. Price £ 4.00. [Published by Macdonald & Co. (Publishers) Ltd., 49/50, Poland Street, London, WIA, 2 LG].

The University Physics Series consist of compact and authoritative monographs on well-defined aspects of pure and applied physics in fields in which research is currently active. Covering a wide range of topics, the series, although addressed primarily to physicists, will be of interest also to chemists, mathematicians, metallurgists and engineers.

The University Physics Series Monographs will be especially useful to students who offer such specialised courses in physics and allied subjects.

The monograph on "Group Theory" is the English translation by Dr. J. B. Sykes of the original German text first published in 1967. In solid-state physics, the most important spatial symmetries are those of crystals, which can be mathematically combined into what is called the space group. The greater part of the book is devoted to the properties of the space groups and the resulting physical consequences. The coverage includes mathematical principles, crystallographic space groups, group theory and quantum mechanics, calculation of energy bands, spin-orbit coupling, time-reversal symmetry, lattice vibrations and selection rules.

The monongraph "Electronic Energy Bands in Solids" bridges the gap between the very elementary introductions to the band theory and the specialised accounts for theoretical researchers. It deals first with the one-electron approximation, the Hartree-Fock equations, origin of bands and main features of the band approximation. It passes on to wave-functions in crystals, formalism of band theory, dynamics of carriers in crystals, band calculation, and classification of bands. A. S. G.

Spectral Theory and Wave Processes. Edited by M. Sh. Birman. (Consultants Bureau and Plenum Press, New York), Pp. 121. Price $ 12.50.

This Special Research Report forms Volume 4 of the series Topics in Mathematical Physics, the original Russian text of which was published by Leningrad University Press in 1970. The volume contains 11 research contributions. The original text has been corrected by the editor for this present English translation.

A. S. G.

Modern Developments in Powder Metallurgy. Edited by Henry H. Hausner. Vol. 4—*Processes*, 1971. Pp. xiii + 593. Price $ 29.50; Vol. 5—*Materials and Properties*, 1971. Pp. xiii + 494. Price $ 29.50. (Published by Plenum Publishing Corporation, 227, West 17th Street, New York, N.Y. 10011, U.S.A.):

These two volumes, which contain the Proceedings of the 1970 International Powder Metallurgy Conference, bring together the latest research findings in powder metallurgy with special emphasis on research and development, production and new applications.

The 45 papers in Volume 4 on "Processes" are arranged in the following five groups in accordance with the main subjects: Powders (5 papers); Powder Consolidation (5); Fundamentals of Sintering (16); Forging of P/M Preforms (13); P/M Mill Shapes (6). The Keynote Address is by Kempton H. Roll, Executive Director of Metal Powder Industries Federation, on "Powder Metallurgy—Facing a New Responsibility".

The 33 papers in Volume 5 on "Materials and Properties" are arranged under the following groups: New P/M Materials (6); Dispersion

Strengthening (6); P/M Refractory Materials and Speciality Products (12); P/M Properties and Testing (9).

The printing is directly from the authors' manuscripts and they are thoroughly illustrated by plates, charts and tables, and include literature references. A. S. G.

Advances in Human Genetics (Vol. 2). Edited by H. Harris and K. Hirschhorn. (Plenum Publishing Corporation, 227, West. 17th Street, New York, N.Y. 10011), 1971. Pp. xiii + 317. Price $ 25.00.

The science of human genetics has become a rapidly expanding area of exploration and intensive research and papers are coming out in very large numbers and from such diverse fields as enzymology, immunology, protein chemistry, cytology, pediatrics, neurology, internal medicine, anthropology, not to speak of mathematical and statistical genetics, which all contribute to an overall understanding of the subject. In these circumstances there is a need for critical review articles which summarize the positions reached in different areas. *Advances in Human Genetics* is intended just to fulfil this purpose. The contributors are well-known specialists in the fields concerned, and the articles are authoritative, and they also indicate new directions for future research.

The present volume under review contains the following five topics dealt with in depth: (1) Glucose-6-Phosphate Dehydrogenase by H. N. Kirkman; (2) "Albiminism" by C. J. Witkop, Jr.; (3) "Acatalasemia" by H. Aebi and H. Suter; (4) "Chromosome and Abortion" by D. H. Carr; and (5) "A Biochemical Genetic View of Human Cell Culture" by W. J. Mellman. A. S. G.

Morphological and Functional Aspects of Immunity. Edited by Kerstin Lindahl-Kiessling, G. Alm, and M. G. Hanna, Jr. (Plenum Publishing Corporation, 227, West. 17th Street, New York, N.Y. 10011, U.S.A.), 1971. Pp. xxvii + 694. Price $ 28.00.

This publication is Volume 12 of Advances in Experimental Medicine and Biology and contains the Proceedings of the Third International Conference on Lymphatic Tissue and Germinal Centers held in Uppsala, Sweden, September 1–4, 1970. The volume contains more than 60 papers presented at the 10 sessions of the Conference, arranged topic-wise, the special addresses of the Chairmen of the sessions, the discussions that followed, and three comprehensive invited lectures. Besides, there was a Free Session at which 16 papers were read.

The papers represent the latest advances in research concerning lymphatic tissues, the diversity of experimental methods employed by various investigators, and the interdisciplinary nature of the subject itself.

Besides immunologists, this publication should be of interest to general biologists, physicians, cancer researchers and clinicians. A. S. G.

Biokybernetik (Band III). Edited by Hans Drischel and Norbert Tredt. (Published by Jena: VEB Gustav Fischer Verlag, DDR-69 Jena, Villengang-2), 1971. Pp. x + 315 with 215 illustrations, leatherette binding, Price 35-M.

The contents of this book are the papers presented at the Second International Symposium on *Biocybernetics* held in Leipzig, September 22–26, 1969. The 52 papers contributed by 74 authors provide a comprehensive survey of the principles and applications of cybernetics in fields of research bordering biology, medicine and psychology.

The papers are grouped under the following main heads: I. General and Theoretical Aspects (17 papers); II. Motor System (12 papers); III. Visual System (19 papers); and IV. Heart, Circulation and Other Homeostatic Mechanisms (4 papers). As many as 37 papers are in English and the rest are in German.

This collection of papers by a number of internationally represented workers shows the growing interest evinced in biocybernetic research and how cybernetics can be used as an intellectual tool for gaining new insights into many problems connected with the functions and mechanisms of complex biological systems. A. S. G.

College Calculus with Analytic Geometry. By M. H. Protter and C. B. Morrey, Jr. (Second Edition, 1971). (Addison-Wesley Pub. Company, Inc., West End House, 11, Hill Place, London W. 1, England), Pp. xii + 900 + App. 82. Price £ 5.60.

The first edition of this book on Calculus was published in 1962 and was well received as a successful text-book on the subject by teachers and students. The book is designed to meet the needs of students taking a three-semester course in calculus at a college or university. The text leans heavily on the intuitive approach, gives many illustrative examples, emphasizes physical applications wherever suitable and has a large selection of graded exercises. Definitions and theorems are stated with care and proofs of simple theorems are given in full.

Many changes have been made in this second edition to meet the suggestions of teachers and students who have been using the first edition of the book. Thus the student is introduced to set notation wherever its use is simple to understand. The sections on relations and inverse functions have been completely re-written to obtain greater precision and improved exposition. A large number of challenging exercises have been included at the end of various sections. Many of the regular exercises have also been changed to introduce variety. Another new feature of this edition is an added appendix on the axioms of algebra and number systems.

A. S. G.

ANNOUNCEMENTS

Symposium on 'Spectroscopic Studies of Astrophysical Interest'

A Symposium on "Spectroscopic Studies of Astrophysical Interest" will be held in Hyderabad, during February 14–16, 1972, under the sponsorship of the University Grants Commission and the Indian National Science Academy. For details please ask for Circular No. 1 from Dr. R. K. Asundi, Convener, c/o Spectroscopy Division, Bhabha Atomic Research Centre, Trombay, Bombay-85.

Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Chemistry to Shri Y. Sitarama Sastry.

Karnatak University, Dharwar, has awarded the Ph.D. degree in Physics to Shri T. S. Mudhole; Ph.D. degree in Statistics to Shri B. N. Nagnur.

The M.S. University of Baroda has awarded the Ph.D. degree in Physics to Kumari Elizabeth Mathai; Ph.D. degree in Chemistry to Shri Dahyabhai Chimanlal Patel and Kumari Nirmala Hariram Pardanani; Ph.D. degree in Zoology to Kumari Maina Valiram Asnani.

Sri Venkateswara University, Tirupati, has awarded the Ph.D. degree in Physics to Shri V. Ramamurthy; Ph.D. degree in Chemistry to Shri G. Raja Reddy and V. Seshagiri; Ph.D. degree in Geology to Shri D. S. R. Narasimha Rao and Shri G. V. S. Rama Rao.

Utkal University has awarded the Ph.D. degree in Mathematics to Shri Minaketan Das; Ph.D. degree in Chemistry to Shri Vyas Muni Pandey and Shri Prabhat Kumar Misra; Ph.D. degree in Entomology to Shri Bipra Charan Misra; Ph.D. degree in Agronomy to Shri N. Sadanandan; Ph.D. degree in Anthropology to Shri Harish Chandra Das; Ph.D. degree in Botany to Shri C. A. Jagadish.

Books Received

Acoustical Holography (Vol. 3) By A. F. Metherell. (Plenum Pub. Corpn., 227, West 17th Street, New York, N.Y. 10011, U.S.A.), 1971. Pp. xv + 299. Price $ 19.50.

Photoelectronic Imaging Devices (Vol. 2). Edited by L. M. Biberman and Sol Nudel Man. (Plenum Pub. Corpn., New York, N.Y. 10011, U.S.A.), 1971. Pp. xxiv + 584. Price $ 25.00.

Electron Spin Resonance of Metal Complexes. Edited by Teh Fu Yen. (Plenum Pub. Corpn., New York, N.Y. 10011, U.S.A.), 1971. Pp. viii + 204. Price $ 15.00.

A Programmed Course in Basic Algebra. By W. C. Beck and J. R. Trier. (Addison Wesley Pub. Co., Inc., West End House, London, W. 1), 1971. Pp. 458. Price $ 2.60.

Biochemical Responses to Environmental Stress. Plenum Pub. Corpn., 227, West 17th Street, New York, N.Y. 10011, U.S.A.), 1971. Pp: xii + 153. Price $ 7.95.

An Experience with Organisms. By D. L. Murray. (Addison Wesley Pub. Co., 11, Hills Place, England, W. 1), 1971. Pp. x + 208. Price 35 *sh.*

Axiomatic Geometry. By M. C. Gemignani (Addison Wesley Pub. Co., Inc., Reading, Mass. 01867). 1971. Pp. viii + 184, Price $ 3.75.

Calculus a Linear Approach (Vol. 1). By J. B. Fraleigh. (Addison Wesley Pub. Co., Inc., Reading, Mass. 01867, U.S.A.), 1971. Pp. vii + 583 + A 69 + I 8. Price 112 *sh.*

High Energy Physics and Nuclear Structure. Edited by Samuel Devons. (Plenum Pub. Corpn., New York, N.Y. 10011), 1970. Pp. xii + 859. Price $ 37.50.

Colloidal and Morphological Behaviour of Block and Graft Copolymers. Edited by Gunther E. Molau. (Plenum Pub. Corpn., New York, N.Y. 10011). Pp. xv + 327. Price $ 14.50.

Neurons and Interneuronal Connections of the Central Visual System. By E. G. Shkol'nik-Yarros. (Plenum Pub. Corpn., New York, N.Y. 10011). 1971. Pp. viii + 295. Price $ 22.50.

3209-71, **Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.**

Cuddalore sandstone is ferruginous (King, 1864, p. 34). Therefore, thorough search is likely to bring to light other isolated patches of Middle Pleistocene deposits in the area.

Dept. of Geology, **EHSANULLAH KHAN.**
A.M.U., Aligarh, *October* 20, 1970.

---

1. King, W., *Mem. Geol. Surv. Ind.*, 1864, **4**, Pt. 2, 1.
2. Matley, C. A., *Rec. Geol. Surv. Ind.*, 1929, **61**, 337.
3. Pilgrim, G. E., *Ibid.*, 1939, **73**, 437.
4. —, The Lower limit of the Pleistocene in Europe and Asia, *Geol. Mag.*, 1944, **81**, 28.

NOTE ON THE OCCURRENCE OF PHOSPHATE IN ARU VALLEY, KASHMIR HIMALAYA

A FIELD survey was recently undertaken around Aru (34° 5′ : 75° 15′) about 13 km. north-west of Pahalgam. The Permians are exposed in the valley. The upper band of limestone of this age is phosphatic. The maximum percentage of P_2O_5 in this area is only 8·65. Though this percentage is not economically important, it was felt that this occurrence should be recorded. The common phosphate mineral is collophane.

GEOLOGY OF THE AREA

In the Aru Valley, about 2 km. south-east of Aru village, the Permians are seen to be overlying the Traps (Fig. 1). The general sequence of this series is as follows[1]:

————TRAPS————
Sandstone
Shale
Limestone { Upper Band
Middle Band
Lower Band
————TRAPS————

The lower band of the limestone is unfossiliferous, dark-coloured and soft, while the middle band, which is the thinnest of the three bands of the limestone, is fossiliferous and dark-coloured. The fossils are:

Coelenterates—*Sinophyllum* sp.
Bryozoans—*Protoretepora ampla*
Polypora n. sp.

Besides these fossils, there are many others which could not be identified due to their poor mode of preservation.

The upper limestone band is siliceous, brownish in colour, and much harder than the two lower bands. This particular band is phosphatic in nature; the range of P_2O_5 is between 4·55% and 8·65%.

Conformably overlying this limestone is sl which is chocolate-coloured, unfossilifer very friable and breaking into needle-sha fragments. The sandstone which conforma overlies the shale is also unfossiliferous.

On the top of this series there is again P jal Trap which is green-coloured and mass

Mode of Occurrence of Phosphate.—' phosphate mineral present in the P mian limestone of the Aru Valley is bl opaque collophane. It occurs in the form pellets (Fig. 2), stringers (Fig. 3), c (Fig. 4), and along the interlaminal parti of the stromatolites (Fig. 5). The size of pellets of collophane ranges from a fraction a millimetre to about two centimetres. tops and the saddles of the branched stroma lites columns display relatively thicker encr tation of the collophane. This mode of occ rence is similar to those described by Valdi from the Pithoragarh area of Kumaon Himala

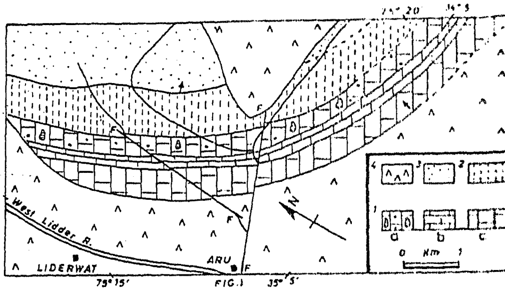
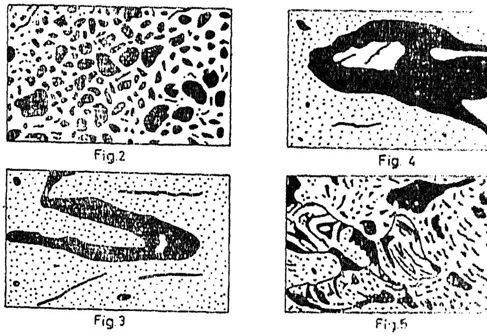


FIG. 1. Geological Map of Aru Valley. 1. Limesto (*a*) Upper Band, (*b*) Middle Band, (*c*) Lower Ba 2. Shale; 3. Sandstone; 4. Panjal Trap.



FIGS. 2–5. Fig 2. Pellets of collophane, $\times \frac{1}{8}$. Fig Stringers of collophane, $\times \frac{1}{4}$. Fig. 4. Clot of colloph $\times \frac{1}{4}$. Fig. 5. Collophane in stromatolite. $\times \frac{1}{5}$.

Chemical analysis of six samples of this P mian limestone, one each from the lower middle bands, and four from the upper ba was carried out, and the results are given Table I.

TABLE I

Chemical analysis of Permian limestones

Sample No.	CaO %	MgO %	P_2O_5 %	Insolubles %	R_2O_3 %	Loss on ignition %
			Upper band			
U.B. 4	40·32	7·60	8·65	19·60	2·96	21·98
U.B. 3	38·64	6·00	7·85	18·10	2·03	27·97
U.B 2	39·24	12·80	5·40	17·70	2·17	22·65
U.B. 1	43·68	8·80	4·55	13·50	2·35	26·87
			Middle band			
M.B. 1	55·68	1·60	0·35	10·20	1·32	31·05
			Lower band			
L.B. 1	52·84	3·60	Absent	9·40	1·07	34·98

The author is thankful to Prof. F. Ahmad for suggesting the area and providing facilities and to Dr. N. Ahmad for guidance. The financial assistance by the Wadia Institute of Himalayan Geology is also thankfully acknowledged.

Dept. of Geology,
Aligarh Muslim University, N. H. HASHIMI.
Aligarh, *October* 12, 1970.

---

1. Hashimi, N. H., "A note on the geology of West Liddar Valley, Kashmir Himalaya," *First Seminar of Wadia Institute of Himalayan Geology*. Delhi, 1970.
2. Valdiya, K. S., "A new phosphatic horizon in the late Precambrian calc-zone of Pithoragarh, Kumaon Himalaya," *Curr. Sci.*, 1969, **38**, 415.

SEXUAL DICHROMATISM IN THE PUFFER FISH, *CHELONODON CUTCUTIA*

NIKOL'SKII[2] stated that the majority of tetradontiform species (except certain marine forms) show clear sexual dimorphism. However, it has not been reported in the Indian freshwater puffer fish, *Chelonodon cutcutia* (formerly known as *Tetraodon cutcutia*).

We have examined several hundred specimens from local lakes (Ramgarh, Mahesra, Sarua and Bakhira) and rivers (Rapti, Rohin, Ami and Ghagrara), throughout the year and have noted marked differences between the males and females of *Chelonodon cutcutia*, manifested primarily in dichromatism, but also in slight morphological differences. The size of the specimens examined ranged between 30 mm. to 80 mm.

Day[1] described the body colouration of the species in these words "Greenish-yellow above, becoming white on the abdomen. A light band passes from eye to eye. A large black ocellus, surrounded by a light edge, on the side anterior to the origin of the dorsal and anal fins. Fins are greyish the caudal being tipped with carmine. There is a red spot on the throat. The whole of the back marked with dark greenish reticulations enclosing lighter spaces".

While this general description is accurate, the pattern of reticulation is clearly distinguishable between sexes. The network in the males consists of numerous polygonal areas free from melanophores. Seen with the naked eye (Fig. 1), the boundaries of these polygons appear intensely dark, thin and broken. These are actually formed by compact, isolated masses of melanophores (Fig. 2 *a*), creating the impression of angles and corners of the polygons.

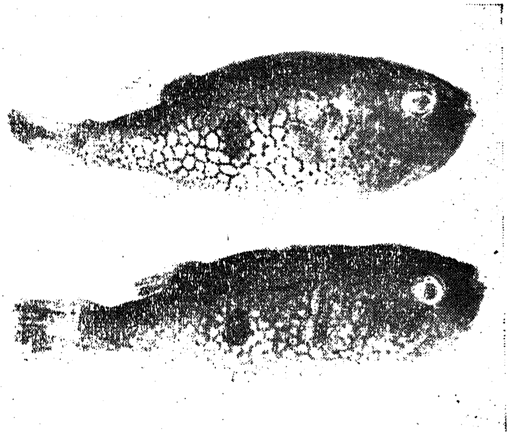


FIG. 1. Chromatic pattern in male and female *Chelonodon cutcutia*: Above : male. Below : Female.

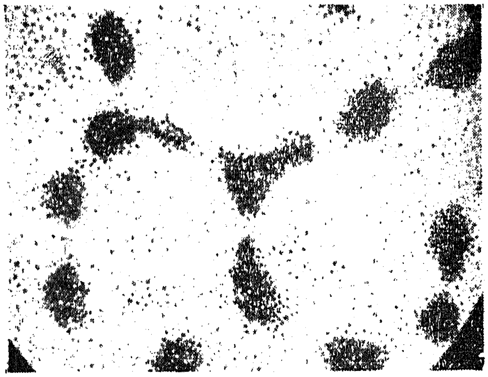


FIG 2(*a*)

In contrast, the female pattern consists of smaller, rounded or oval areas rather than polygons (Fig. 1). The boundaries of these oval areas are thick, continuous and relatively less dark than the male pattern. This is due to sparsely distributed melanophores in the spaces between melanophore-free areas (Fig. 2 *b*).

Microscopic examination of the skin revealed the presence of two layers of chromatophores, one deeper and the other superficial. The distribution of the melanophores in the deeper layer is similar in both sexes, while the differences observed externally and described above are due to the superficial layer.

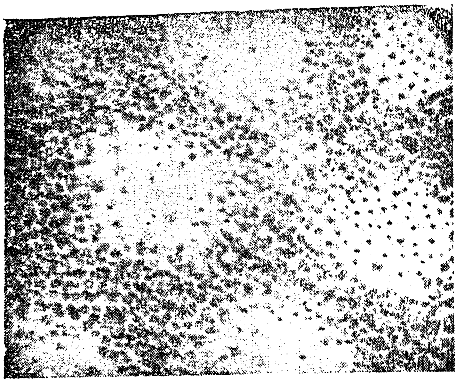


FIG. 2 *b*

FIG. 2. Melanophores in the skin of male (*a*) and female (*b*) *Chelonodon cutcutia*, × 25.

Note the dark patches of melanophores in the male (*a*) and diffused, sparsely distributed melanophores in the female (*b*).

Also, the carmine spots on the caudal fin mentioned by Day (*Ibid.*) are not present throughout the year, but occur only during the breeding season. The carmine band on the tip of the caudal occurs in both sexes, but the carmine patch on the throat is prominent in the males, but if present in females it is only slightly developed. In addition, a small genital papilla is present in males, but is feebly developed in females.

Dept. of Zoology, Krishna Swarup.
Univ. of Gorakhpur, Devendra Kumar Singh.
Gorakhpur, *October* 21, 1970.

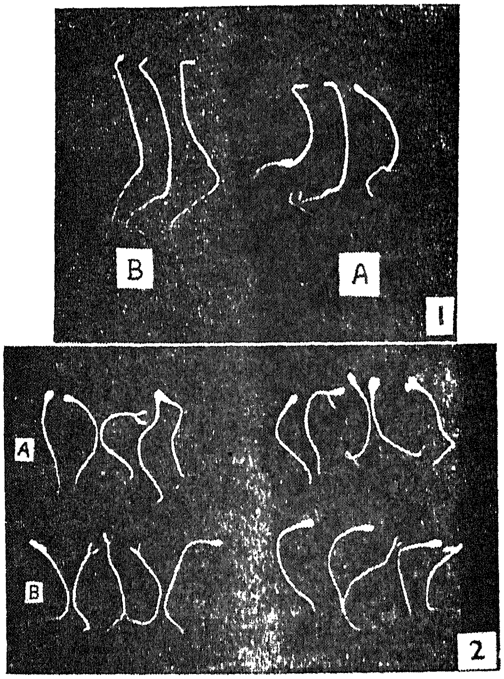
---

1. Day, F., *The Fishes of India*, William Dawson and Sons Ltd. London, 1873, p. 703.
2. Nikol'skii, G. V., *Special Icht'yology*, Second edition, Israel Program for Scientific Translations, Ltd., Jerusalem, 1961, pp. 472–474.

NIACIN INHIBITION OF ROOT GROWTH IN LETTUCE SEEDLINGS

It is well known that niacin is synthesized during germination even in darkness.[1] In isolated pea roots deficient synthesis of niacin results in reduced meristematic activity, and in a progressive reduction in the dimensions of individual cells.[2] It has been observed that in monocotyledons, the addition of niacin greatly inhibited germination and subsequent seedling growth.[3] It appeared to be of interest, therefore, to investigate the role of added niacin in germination and seedling growth of dicotyledonous plants.

Lettuce seeds (*Lactuca sativa* var. Cabbage) were allowed to germinate in sterilised petri-dishes lined with filter-paper and moistened with various concentrations of aqueous niacin solutions, and in distilled water as controls. The seeds were thoroughly washed with distilled water before they were used. Germination experiments were performed at 25° C. ± 2° C. in dark or in light (tube light) in specially devised chambers.



FIGS. 1–2. Fig. 1. Six days old seedlings growth in distilled water as control. A, Light; B, dark. Fig 2. Six days old Seedlings Growth in 500 ppm Niacin solution showing root inhibition. A, Light; B, Dark.

It would be evident (Figs. 1 and 2) that both in light as well as in dark the seedlings grown in 500 ppm niacin solution indicated a marked inhibition of root growth. However, the suppression of hypocotyl was observed to be almost absent (Table I). This would appear to be in contrast with the results with monocotyledonous plants, already reported, in which case the entire seedling growth was adversely affected.[3] It is interesting to note on the other hand that in dicotyledonous plants, the chemical did not hamper the growth of hypocotyl and cotyledonary leaves, but at the same time the development of primary seedling roots were more or less completely suppressed at the end of 10 days observation period. Lower concentrations of the chemical, *viz.*, 10, 25, 50 and 100 ppm did not affect the seedling root growth adversely (Table II). As to the suppression of root development, the effective concentration of the chemical was found above 250 ppm. Germination of the seeds was observed to be 93% to 95% in both treated and untreated seeds, and was irrespective of dark or light.

TABLE I

Effect of niacin (500 ppm) on root and hypocotyl growth

	Mean length in cm.			
	In niacin		In water	
	Root	Hypocotyl	Root	Hypocotyl
1. Light	1·1 ± 0·2	2·4 ± 0·3	4·3 ± 0·3	2·6 ± 0·2
2. Dark	1·0 ± 0·2	2·5 ± 0·3	4·2 ± 0·3	2·5 ± 0·3

Results of four days seedling growth.

TABLE II

Effect of various concentrations of niacin on suppression of seedling root

Time period in days	Mean length* in cm.							
	Concentration of niacin in ppm							
	0	10	25	50	100	250	500	750
2	1·5	1·4	1·5	1·6	1·5	1·2	0·5	0·3
4	4·3	4·3	4·4	4·4	4·3	3·8	1·1	1·0
6	5·1	5·0	5·2	5·0	5·2	4·0	1·3	1·1

* Variation of ± 0·2 cm.

Thus the results presented indicate that in contrast to its behaviour in the case of monocotyledonous seeds, niacin appears to be ineffective in influencing the germination of dicotyledonous seeds, although the subsequent growth of the seedling roots is drastically inhibited. Available evidence relating to mode of action of niacin indicates that this vitamin might disrupt the endogenous auxin levels by competing for tryptophan in the substrate-induced, biosynthesis.[4,5] It remains to be explored, however, whether niacin could affect the seedling growth of lettuce in a similar way.

Lab. of Tissue Culture
and Biochemistry,
Dept. of Botany,
University of Jodhpur,
Jodhpur (India), *September* 14, 1970.

PRAKASH MULLICK.
U. N. CHATTERJI.

---

1. Bonner, J. and Bonner, H., *Vitam. and Horm.*, 1948, **6** 225.
2. Addicott, F. T., *Bot. Gaz.*, 1941, **102**, 576.
3. Prakash Mullick and Chatterji, U. N., *Curr. Sci.*, 1969, **38**, 523.
4. Nason, A., *Amer. J. Bot.*, 1950, **37**, 612.
5. Hasse, K., *Encyclopedia of Plant Physiology*, Ed. W. Ruhland, 1958, **9**, 177.

ANTIFUNGAL VAPOUR ACTION OF VFI TABLETS AGAINST MICROBIAL DETERIORATION AND SEED-BORNE PATHOGENS

USE of chemicals as a means of controlling plant diseases and checking deterioration and spoilage of various agricultural commodities in transit and storage has been the subject of intensive research in India during the last few years. Recent work of Dharam Vir[1-3] and Gaur and Raychaudhuri[4] have shown that such diseases are amenable to control measures, which are simple in execution and fairly economical. Recently, the Defence Research Laboratory, Kanpur, has produced a volatile fungal inhibitor compound (VFI) which has been formulated in the form of tablets. Studies have been initiated at the Indian Agricultural Research Institute, New Delhi, to find out the effectiveness of this compound against diseases of fruit and vegetables occurring in transit and storage and some seed-borne pathogens. The present paper deals with investigations pertaining to vapour action of VFI tablets against ten fungi responsible for such type of diseases.

The VFI tablet was placed inside a petri-plate containing potato-dextrose-agar on a piece of alkathene cloth cut to a size of 4 sq. cm. so as to avoid its contact with the medium. Each plate was inoculated with four different fungi by placing small agar bits of live cultures on the P.D.A. on four sides. Suitable checks were also maintained and each treatment was replicated 10 times. The plates were incubated at 25° C. and examined periodically for recording the growth of fungi. The names of various fungi used in the studies together with the results of the experiments, are presented in Table I.

The data collected up to a period of two weeks after inoculations, have shown that all the fungi used in the tests failed to grow in the presence of VFI tablets. In check plates, however, normal growth of various fungi was observed from the points of inoculations (Fig. 1). These studies clearly reveal the antifungal vapour action of the VFI tablets against the fungi tested.

TABLE I

Antifungal vapour action of VFI tablets against various fungi

Name of the fungus	Growth on potato-dextrose agar at the point of inoculation	
	VFI tablet present	(Check) VFI tablet not present
Helminthosporium oryzae ..	−	+
Rhizoctonia bataticola ..	−	+
Aspergillus niger ..	−	+
Penicillium expansum ..	−	+
Colletotrichum gloeosporoides ..	−	+
Helminthosporium gramineum	−	+
Alternaria tenuis ..	−	+
Colletotrichum papaya ..	−	+
Fusarium coerullum ..	−	+
Pythium aphanidermatum ..	−	+

N.B. (−) denotes no growth, (+) denotes growth.

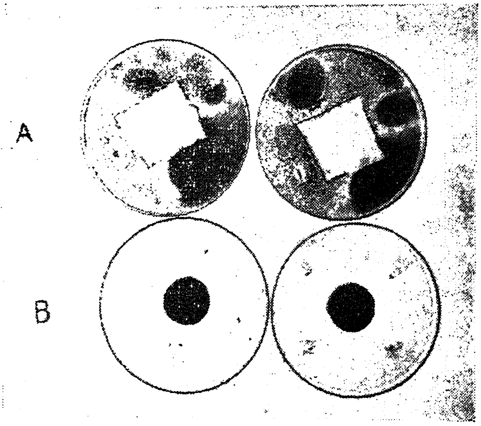


FIG. 1 A-B. Showing antifungal vapour action of **VFI** tablet against *R. bataticola*; *H. oryzae*, *A. tenuis* and *A. niger*.

B. Series represent the treated plates where VFI tablet has been kept on a piece of alkathene cloth. The white square in A (check plates) represent the alkathene cloth.

The authors are grateful to Dr. S. P. Raychaudhuri for his keen interest during the course of these investigations.

Divn. of Mycology and
Plant Pathology,
Indian Agric. Res. Inst.,
New Delhi-12, *September* 26, 1970.

DHARAM VIR.
ASHOK GAUR.

---

1. Dharam Vir, *Jour. Post.—Gr. School*, I.A.R.I., New Delhi, 1967, **5**, 62.
2. —, *Indian Fmg.*, 1968, **17**, 23.
3. —, *Proc. International Symp. Plant Pathology*, New Delhi, 1970, p. 316.
4. Gaur, Ashok and Raychaudhuri, S. P., *Hindustan Antibiot. Bull.*, 1970, **12**, 144.

NOMENCLATURAL REVISION OF THE COMMON RUST FUNGUS AFFECTING SUGARCANE

DURING the course of his work on rust fungi of Maharashtra State, India, the writer noticed that Uppal, Patel and Kamat[1] had recorded a rust fungus on *Bambusa* sp. under *Puccinia* sp., and subsequently it was reported by Patel, Kamat and Bhide[2] as *Puccinia melanocephala*. Repeated attempts by the writer, however, to collect this fungus on *Bambusa* spp. in this state failed. It was then suspected that:

(1) The report of *Puccinia melanocephala* on *Bambusa* sp. from Maharashtra State (old Bombay State) was incorrect and that it in fact represented some stage of the rust *Dasturella bambusina*,[3] which is of common occurrence; or

(2) *Puccinia melanocephala* and *Dasturella bambusina* were the duplicated names of the same fungus, the early developmental stage of which at its two-tier stage perhaps is mistaken for two-celled teliospores of *Puccinia*; or

(3) The host of *Puccinia melanocephala* needed a recheck.

The confirmation of the first doubt could not be undertaken since the material on which the previous state report was based[1,2] was not available. The report of *Puccinia melanocephala* on *Bambusa* sp. from this State was, therefore, considered as dubious.

In order to confirm on the rest of the two doubts, the type material of *Puccinia melanocephala* (Butler No. 512) was secured from Stockholm Museum through the courtesy of Dr. Sten Ahlner, First Curator. The type material was accompanied with the photomicrographs and suggestions by Dr. G. B. Cummins, Arthur Herbarium, Purdue University, U.S.A. The critical examination of the type material overruled the second doubt, since the rust agreed with the original description by the Sydows[4] under *Puccinia melanocephala*. Thi critical examination, however, revealed that the host in this material did not belong to any member of *Arundinaria* as originally identified by the Sydows, instead, it was a member o *Erianthus* as suggested by Cummins, thus confirming the third doubt, and was indicated so by the presence of orange-coloured-pigmented epidermal cells disposed at intervals. Furthermore, on the basis of comparative morphological studies, it was confirmed that the host wa *Erianthus ravennae* (L.) P. Beauv. [= *Saccharum ravennae* (L.) Murray]. The rust fungu agreed in all respects with the common sugarcane rust, namely, *Puccinia erianthii* Pad. an

Khan (= *P. sacchari* Patel, Kamat and Padhye nom. nud.). This was further confirmed by comparing the type materials of *Puccinia erianthii* and *P. sacchari*, obtained through the courtesy of Dr. S. P. Raychaudhuri, I.A.R.I., New Delhi, with the Stockholm material (Butler No. 512).

It is obvious, therefore, that the host for *Puccinia melanocephala* is *Erianthus ravennae* and not *Arundinaria* sp. (= *Bambusa* sp.) as originally identified, and that the same rust is nomenclaturally duplicated. Furthermore, since *Puccinia melanocephala* antidates *Puccinia erianthii* (= *P. sacchari*), the former name takes up precedence over the latter according to International Code of Botanical Nomenclature. The revised nomenclature for the common rust on sugarcane is, therefore, as follows:

Accepted Name: *Puccinia melanocephala* Syd. in Syd. H. and P. Syd. (*Ann. Mycol.*, **5**: **500**, 1907).

Holotype: On *Erianthus ravennae* (L.) P. Beauv. Butler No 512!

Synonym: *Puccinia erianthii* Pad. and Khan (*I.M.I. Kew. Mycol. Papers*, 10: 10, 1944). On *Erianthus fulvus* Nees, Pad. No. 688!; I.A.R.I., No. 10286!

Puccinia sacchari Patel, Kamat and Padhye nom. nud.

On *Saccharum officinarum* L., I.A.R.I. No. 19794.

As regards the status of this rust on sugarcane and the other rusts on the same or allied hosts, the treatment by Cummins[5] is accepted.

I am grateful to Prof. M. N. Kamat for his interest and encouragement.

Maharashtra Association A. V. SATHE.
for the Cultivation of Science,
Poona-4, India, *September* 23, 1970.

---

1. Uppal, B. N., Patel, M. K. and Kamat, M. N., "Fungi of Bombay," *Agric. Dept. Bull.*, **1935**, p. 170.
2. Patel, M. K., Kamat, M. N. and Bhide, V. P., *Fungi of Bombay Suppl. I. Indian Phytopath.*, **1949**, **2**, **142**.
3. Sathe, A. V., "Uredinales of Maharashtra State, India," *Bull. Bot. Survey of India* (In press).
4. Sydow, H. and Sydow, P., "Fungi Indiae Orientalis —Pars II," *Ann. Mycol.*, 1907, **5**, 485.
5. Cummins, G. B., "The species of Puccinia parasitic on Andropogoneae," *Uredineana, Encyl. Mycol.*, **1953**, **24** (**4**), **1**.

EFFECT OF ANTIBIOTICS ON NUCLEIC ACID AND PROTEIN SYNTHESES IN *AZOTOBACTER CHROOCOCCUM* AND *RHIZOBIUM TRIFOLII*

ANTIBIOTICS and antimetabolites are known to interfere with nucleic acid and/or protein synthesis.[1-4] The present communication is a preliminary report on the effect of penicillin, streptomycin and chloramphenicol on these two processes in two nitrogen-fixing bacterial systems, a symbiotic *Rhizobium trifolii* and an asymbiotic *Azotobacter chroococcum*. The incorporation of radioactive phosphate ($^{32}PO_4$) and sulphate ($^{35}SO_4$) into the TCA-insoluble fractions was taken to reflect the nucleic acid and protein synthesis respectively. The details of the kinetics of incorporation will be reported elsewhere.

Commercial preparations of penicillin G sodium (Squibb), streptomycin sulphate (Merck, Sharp and Dohme) and chloramphenicol succinate (Parke-Davis) were used and the concentrations of the antibiotics chosen were three times those required for inhibition of growth. Organisms were grown for 72 hr. and then exposed to antibiotics for 3 hr. to examine the incorporation of the tracers.

For $^{32}PO_4$ incorporation, the organism was incubated at 28 ± 2° C. for 3 hr. with constant shaking in 200 ml. medium, containing radioactive potassium phosphate (0·25 μc./ml.) and suitable amounts of the antibiotics with and without an energy source (4% sucrose). For $^{35}SO_4$ incorporation, radioactive sodium sulphate (1·25 μc./ml.) was added instead of phosphate. The experiments were conducted with a parallel set of controls without any antibiotics. Incorporation was stopped by quick centrifugation (12,000 r.p.m.) and the cells were washed with saline. The washed cells were twice extracted with 2·5 ml. cold 10% TCA and again with 2·5 ml. cold 5% TCA. The residue was washed twice with saline and suspended in a 10 ml. volume of distilled water. Aliquots of 1 ml. were plated and counted in a thin-window Geiger counter. Corrections were made for the background radiation.

Table I shows the percentage inhibition of the incorporation of $^{32}PO_4$ and $^{35}SO_4$ in presence of antibiotics. In contrast to $^{32}PO_4$ incorporation, chloramphenicol brings about a marked inhibition in the incorporation of $^{35}SO_4$ in both organisms (40-45%). This antibiotic is known to be a specific inhibitor of protein synthesis, without affecting the nucleic acid synthesis.[5] Streptomycin inhibits the incorporation of $^{32}PO_4$ and $^{35}SO_4$, indicating that this drug inhibits both the nucleic acid and protein syntheses in these organisms. Although the action of this antibiotic is still not clear, it seems that it acts in an indirect way. Penicillin, which is known to inhibit specifically the cell-wall synthesis, has little effect on the incorporation of $^{32}PO_4$ and $^{35}SO_4$. However, a marked inhibition of about 54% in the incorporation of $^{35}SO_4$ in the protein fraction has been reported in *Azotobacter vienelandii* in presence of penicillin[1] and this interference may be most probably in an indirect way.

TABLE I

Percentage inhibition of $^{32}PO_4$ and $^{35}SO_4$ incorporation into the TCA-insoluble fractions of Azotobacter chroococcum *and* Rhizobium trifolii *in presence of antibiotics*

Antibiotic (mg./ml.)	With sucrose		Without sucrose	
	Nucleic acid ($^{32}PO_4$)	Protein ($^{35}SO_4$)	Nucleic acid ($^{32}PO_4$)	Protein ($^{35}SO_4$)
Azotobacter chroococcum				
Penicillin (0·004) ..	2·2	8·0	1·8	9·3
Streptomycin (0·04)	13·5	25·9	16·3	29·1
Chloramphenicol (0·45)	2·5	41·7	2·1	45·1
Rhizobium trifolii				
Penicillin (12·0) ..	1·2	4·0	0·18	1·8
Streptomycin (0·09)	14·7	20·0	18·6	22·2
Chloramphenicol (4·5)	1·3	39·0	1·6	40·7

The presence and absence of an energy source (4% sucrose) has been found to have no appreciable effect on the general pattern of inhibition by the antibiotics (Table I).

Our thanks are due to Dr. W. V. B. Sundara Rao for his interest, and to Shri S. C. Mehta and Dr. B. V. Subbiah for providing facilities.

Divn. of Microbiol., R. P. SETHI.
I.A.R.I., New Delhi, G. S. VENKATARAMAN.
September 30, 1970.

---

1. Chakravorty, M., *Nature*, 1960, **187**, 239.
2. — and Burma, D. P., *Biochem. Biophys. Acta*, 1962, **55**, 110.
3. Gale, E., *Promotion and Prevention of Synthesis in Bacteria*, Syracuse Univ. Press, 1968, p. 99.
4. Mehta, S. L., Naik, M. S. and Das, N. B., *Indian J. Microbiol.*, 1969, **9**, 12.
5. Gale, E. and Folkes, J. B., *Biochem. J.*, 1953, **53**, 493.

POLLEN DIMORPHISM IN *WEDELIA BIFLORA* DC.

POLLEN-GRAINS of Compositae are interesting because of many structural manifestations on their walls like elaborate and beautiful system of sculpturing, formation of different types of spines, variation in size, number and arrangement of pores, etc. According to Erdtman it is a eurypalynous family still insufficiently studied.[1] Detailed pollen characters and fine structure of many taxa of this family are recorded in standard reference works on palynology.[1–4] Variations observed in pollen structure of *Wedelia biflora* are reported here. Pollen size of *W. urticaefolia* is recorded before.[4]

Hoffman[5] classifies *Wedelia* as the 418th genus of the family under the tribe Heliantheae-Verbesininae along with other well-known genera like *Eclipta, Helianthus, Rudbeckia,* and *Spilanthes. W. biflora* is a sprawling bush, with yellow flower-heads, commonly found as a weed on the coastal as well as inland regions. It flowers throughout the year like many other members of this family. The material was collected from plants growing in the campus of Singapore University and pollen slides were prepared, according to acetolysis method,[1] by using anthers from fully mature fresh flowers. Voucher herbarium specimen is deposited in the University Herbarium, SUH No. UM 14. In order to make sure that we were not observing either immature grains or those formed in the damaged anthers anthesis of flowers was followed and undamaged healthy anthers were collected.

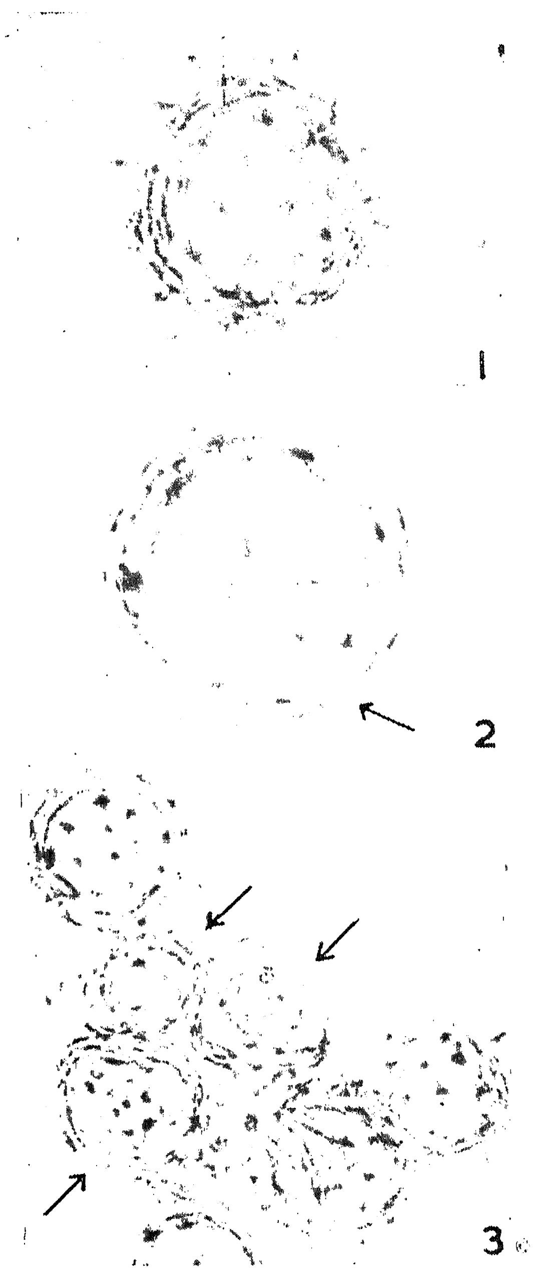
The pollen-grains in *W. biflora* are spheroidal with a thick characteristic spinascent exine (Type I) like in *Helianthus, Spilanthes* and others[1,2] (Fig. 1). Out of the 300 grains studied, 98% of the grains showed spinascent exine. In the other 2%, the grains (Type 2) were smaller in size, with apertures either indistinct or absent. The pollen wall was mostly smooth or it had slightly raised knobs or humps (Figs. 2, 3). However, wall thickness was similar to normal grains. The measurements and the structural variations of the two types of grains are given in Table I. The size of the normal pollen-grains of this species is very similar to that of *W. urticaefolia.*[4]

Dimorphic grains showing size and structural variations are reported from time to time in different taxa.[6,7] Considerable irregularities during meiosis or change in ploidy may result in the formation of giant or small microspores.[8–10] Apart from size differences, such pollen-grains may show similar shape and structure. But it is less common to find major structural variations like presence or absence of spines, pores, etc., in the pollen of the same taxon and the present report is one such case. Some general explanations are offered accounting for the differences seen in the varied forms of the pollen-grains either within the same species or among the closely related species. These include varying internal and external environmental conditions that prevail during pollen development.[2] It is clear that further experimental research is necessary to identify the causal factors that may control the morphogenesis of the pollen wall.

TABLE I

Structural variations in the two types of pollen-grains in Wedelia biflora

	Character	Type 1	Type 2
1.	Shape ..	Spheroidal	Spheroidal
2.	Size—Average diameter including spine length	27 μ (range 25·6–28 μ)	19·6 μ (range 16·8–22·4 μ)
3.	Exine thickness	2·4 μ	2·4 μ
4.	Spines ..	Long, tapered, erect, 4·0 μ long	Short, stout and reduced to humps, 1·0 μ long
5.	Interspinal distance	4·8 μ	4·8 μ



FIGS. 1–3. Fig. 1. A normal spinascent pollen-grain, × 1,555. Fig. 2. An abnormal aspinascent grain. Spine bases form small humps (indicated by arrow), × 2,020. Fig. 3. A group of normal and abnormal grains (indicated by arrows). Spines are poorly formed in the grains indicated, × 925.

Department of Botany, A. N. RAO.
University of Singapore, E. T. ONG.
Singapore-10, *September* 12, 1970.

---

1. Erdtman, G., "Pollen morphology and plant taxonomy," *Angiosperms*, The Chronica Botanica Co., Waltham, Mass., U.S.A., 1952.
2. Wodehouse, R. P., *Pollen-Grains*, McGraw-Hill Book Co., New York, 1935.
3. Skvarla, J. J. and Larson, D. A., *Grana Palynol.* 1965, 6, 210.
4. Nair, P. K. K., *Pollen Grains of Western Himalayan Plants.* Asia Publishing House, New Delhi, 1965.
5. Hoffman, O., In *die Naturlichen pflanzen familien*, 1897, 4, 87.
6. Nair, P. K. K., *J. Sci. & Industr. Res.*, 1958, 17, 35.
7. Gupta, R. C. and Roy, S. K., *Curr. Sci.*, 1970, 39, 264.
8. Raghavanshi, S. S. and Joshi, S., *Cytologia*, 1964, 29, 61.
9. Joshi, S. and Raghavanshi, S. S., *Grana Palynol.*, 1965, 6, 186.
10. Withner, C. L., *The Orchids*, The Ronald Press Co., New York, 1959.

SUITABILITY OF DIFFERENT TYPES OF GLASSWARE IN SPORULATION STUDIES ON *CERCOSPORA PERSONATA**

COPIOUS production of spores is induced in *Cercospora personata* (Berk. Curt.) Ell. *et* Everh., when cultures are exposed to light from "cool white" (TL 40 w., Osram) fluorescent lamps at 23–27° C.[1] Enough of near ultraviolet (NUV) radiation is emitted by such lamps to induce sporulation.[2] All types of glassware do not transmit radiation of this wavelength (NUV) to the same extent.[2] In order to select for sporulation studies, a suitable type of glassware from among the ones available in this country, cultures were raised in different brands of Petri-dishes and exposed to light from "cool white" fluorescent tubes. The results are presented in Table I.

TABLE I

Brand name of petri-dish		No. of spores/plate (average of 3 plates)
Pyrex	..	2,126,000
Corning	..	1,241,000
Anumbra	..	1,104,000
Borosil	..	455,000
D.G.W.	..	145,000

It is seen that Pyrex Petri-dishes give the best results. Corning and Anumbra are the next best. Borosil and D.G.W. are rather unsuitable for sporulation studies.

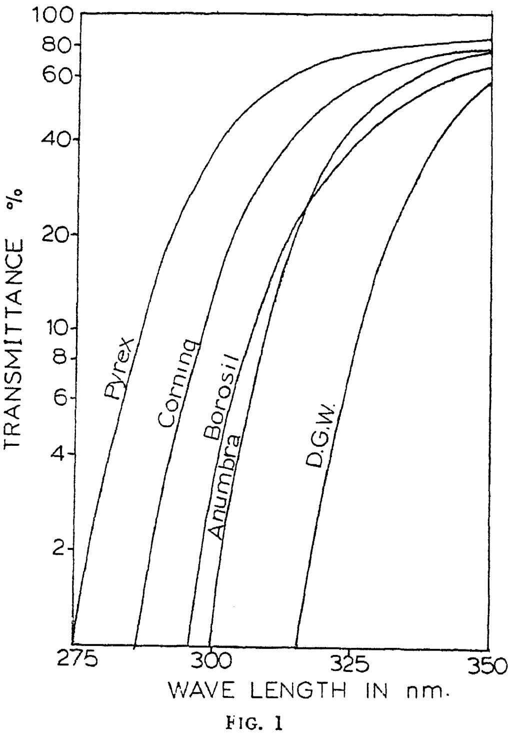


FIG. 1

To find out how these different types of glassware differed in their ability to transmit radiation in the UV region the Petri-dishes were examined in a UNICAM SP-800 recording spectrophotometer. A comparison of the spectral characteristics (*see* Fig. 1) with the sporulation data in Table I suggests that the ability to transmit radiation in the region between 325 and 350 nm. seems to determine the suitability of the glassware for getting good sporulation.

In our experiments, Corning brand Petri-dishes have been chosen because of ease of availability.

I am deeply indebted to Dr. R. N. Swamy for his guidance, and I thank Prof. T. S. Sadasivan for critically going through this article. I am grateful to the University Grants Commission for the award of a Junior Research Fellowship.

University Botany Lab., K. S. BHAMA.
Madras-5, *October* 20, 1970.

---

*Memoir No. 95 from the Centre for Advanced Study in Botany.

1. Bhama, K. S., and Swamy, R. N., *Curr. Sci.*, **1969**, **38** (23), 570.
2. Leach, C. M., *Proc. Int. Seed Test Ass.*, **1967**, **32**, 565.

AN INTERGENERIC CROSS IN THE CUCURBITACEAE (*COCCINIA INDICA* W. AND A. × *BRYONOPSIS LACINIOSA* ARN.)

INTERGENERIC hybridisation in Cucurbitaceae is very rare. There is only one previous report[1] where a cross between *M. charantia* and *T. anguina* was successful but the F_1 did not grow well. In the present investigation, a successful intergeneric hybridisation between *C. indica* and *B. laciniosa* is being reported which was made to understand and establish phylogenetic relationship, breeding affinities, sex expression and mode of inheritance between two wild genera. *C. indica* a dioecious perennial climber with tuberous roots; whereas *B. laciniosa* is a monoecious wild annual climbing herb. Only 5% of crosses between *C. indica* × *B. laciniosa* were successful. Reciprocal cross did not succeed. Altogether, seven fruits with 36 healthy seeds were obtained, but on sowing, only 28 germinated. Six seedlings died later, but 22 seedlings grew luxuriantly.

All the F_1 plants were dioecious with only female flowers (Fig. 3). Most of the developing buds aborted at early stage of development, only a few of them developed into mature flowers. The characters of the parents and F_1 hybrids are compared in Table I.

The characters of *C. indica* dominant in the hybrid were:

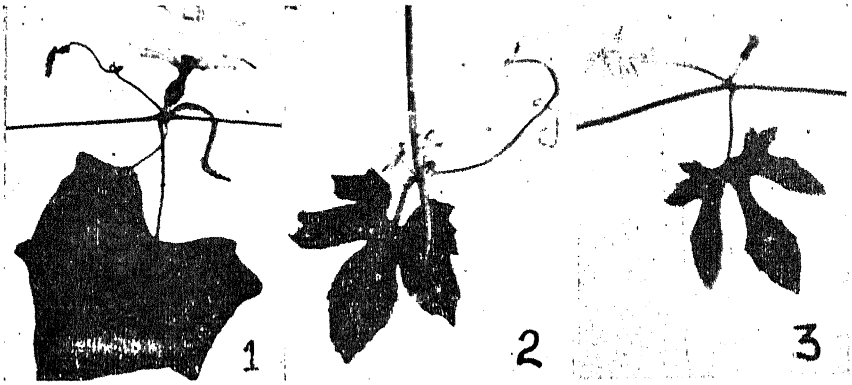
(1) Perennial habit; (2) dioecism; (3) shape and colour of flower; (4) opening time of flower; (5) tuberous root.

TABLE I

Comparison of characters between C. indica, B. laciniosa *and their* F_1 *hybrid*

Character	*C. indica*	*B. laciniosa*	F_1 hybrid
1. Plant ..	Dioecious, perennial with tuberous roots	Monoecious, annual with simple roots	Dioecious, perennial with tuberous roots
2. Leaf :			
Shape ..	Palmately 5-lobed	Deeply trilobed or 5-lobed	Deeply trilobed or 5-lobed
Size ..	8·2×9·1 cm.	8·4×8·3 cm.	6·3×6·2 cm.
Apex ..	Round	Acute	Acute
Colour ..	Dark green	Light green	Light green
Surface ..	Both surface smooth	Upper scabrous	Upper scabrous
Margin ..	Denticulate with nerve tips	Denticulate, nerve tip absent	Denticulate with nerve tips
Glands ..	5–10 glistering glands at the leaf-base	Absent	Absent
3. Tendril ..	Simple	Bifid	Both simple and bifid
4. Inflorescence ..	Solitary axillary	2–3 female flowers surrounded by many male flowers in each leaf axil	Solitary axillary, 2–3 female flowers in cluster
5. Female flowers:			
Size ..	Large	Small	Medium
Petal colour	White	Greenish-yellow	White
Opening time	Morning	Late evening	Morning
Ovary shape	Oblong	Globose	Oblong
6. Fruit:			
Shape ..	Oblong	Spherical	Spherical*
Pulp ..	Red	Bluish-green	Red
Colour ..	Deep-red	Yellowish-green	Red
7. Seed:			
Shape ..	Oblong base with two deep marks	Pear-shaped	Oblong base with two deep marks*
No. per fruit	175	12	1·9

* Fruits and seeds in F_1 hybrid could not be obtained as all the F_1 plants were female. However, fruits were obtained by back-crossing with *C. indica.*



FIGS. 1–3. Fig. 1. *C. indica*—A branch showing a single ♀ flower in a leaf axil. **Fig. 2.** *B. laciniosa*—A branch showing a cluster of ♂ and ♀ flowers in a leaf axil. **Fig. 3.** F_1 hybrid—A branch showing a single ♀ flower in a leaf axil.

The following characters of *B. laciniosa* were dominant in the hybrid:

(1) General appearance of the hybrid; (2) shape, texture, roughness and lobing of leaves.

The following characters of the hybrid were intermediate between the two parents: (1) tendril; (2) inflorescence; (3) size of flower.

The breeding affinities of two genera indicate that they are closely related. Their phylogenetic relationship and taxonomic status deserve a close look but should await detailed meiotic studies of F_1 hybrids both ways.

Crosses between *B. laciniosa* ♀ × *C. indica* ♂ failed completely. Back-crossing with *B. laciniosa* also failed but that with *C. indica* as ♀ parent succeeded.

This research has been financed in part by a grant made by the United States Department of Agriculture under PL 480.

Dept. of Botany, R. P. ROY.
Patna University, P. M. ROY.
Patna-5, *October* 21, 1970.

---

1. Sitaram Patrudu, S. and Krishnamurti, P., *Curr. Sci.*, 1934, 2, 431.

A NOTE ON THE SUCCESSIVE EGG-LAYING WITHOUT MATING OF SOME INDIAN CRABS

INSTANCES in crabs where egg-laying occurs more than once without repeated copulation have been recorded by a few authors. Hartnoll (1965)[1] observed *Hyas coarctatus* and *Inachus dorsettensis* as laying two sets of eggs and *Microphrys bicornutus* laying upto four sets of eggs without a male being present. He also mentioned that in *Pisa tetraodon* eight ovulations were recorded after one mating.

TABLE I

Name of species of crabs	Date of collection of ovigerous females, and condition of eggs	Date of release of first observed batch of eggs	Date of observation of second observed batch of eggs	Date of observation of third observed batch of eggs	Remarks
Philyra corallicola	17-8-1967 eggs dark in colour showing full development	20-8-1967 14·10 hrs.	20-8-1967 17·15 hrs.	1-9-1967	3 batches of eggs could be observed. On 6-9-1967 the eggs were shed in pre-matured condition
Pinnotheres sp.	28-8-1967 eggs dark in colour; fully developed	30-8-1967	2-9-1967	..	2 batches of eggs could be observed. On 4-9-1967 the eggs were shed in pre-matured condition
Doclea gracilipes	16-9-1968 eggs orange-red in colour; developing eggs	24-9-1968	30-9-1968	..	2 batches of eggs could be observed. On 24-9-1968 the female shed eggs in pre-matured condition and developed a fresh batch on 30-9-1968
Schizophrys aspera	17-10-1968 eggs orange-red in colour; developing eggs	22-10-1968	2-11-1968	..	2 batches of eggs could be observed. The female shed pre-matured eggs on 22-10-1968 and became ovigerous on 2-11-1968
Pilumnus vespertilio	20-11-1968 eggs dark in colour; almost developed	25-11-1968	27-11-1968	..	2 batches of eggs could be observed Female shed the eggs on 29-11-1968 in pre-matured condition

Although studies on the larval development of crabs have been carried out by several authors in India, the successive egg-laying without intermediate copulation does not appear to have been reported so far except by Silas and Alagaraswami (1967)[2] who mentioned, in their resume of the work done on *Pinnotheres* sp., that female crabs became ovigerous in laboratory tanks in the absence of a male.

During the course of studies on larval hatching in the laboratory in Bombay and at Ratnagiri, several ovigerous female crabs of different species were collected and reared in separate laboratory tanks. On many occasions it was noticed that female crabs of some of these species after release of the first batch of eggs, became ovigerous either on the same day, as in *Philyra corallicola* Alcock, or after a few days.

Actual instances together with dates of observations are given in Table I.

I am grateful to the Department of Fisheries, Maharashtra State, for facilities, and to Dr. N. K. Panikkar, Director, National Institute of Oceanography, Goa, for useful suggestions.

Taraporevala Marine P. S. GORE.*
Biological Res. Station,
Bombay, *October* 15, 1970.

---

* National Institute of Oceanography, P.B. No. 1913, Cochin-18, India.

1. Hartnoll, R. G., *Crustaceana*, 1965, 9, Part I, 16.
2. Silas, E. G. and Alagaraswami, K., *Proceedings of the Symposium on Crustacea*, 1965, Part III, pp. 1161, 1227.

REVIEWS AND NOTICES OF BOOKS

Annual Review of Physical Chemistry, Vol. 21. Editor : H. Eyring. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California, 94306, U.S.A.), 1970. Pp. 655. Price U.S.A. $ 10.00 ; Foreign : $ 10.50.

The 1970 volume of the *Annual Review of Physical Chemistry* contains 21 chapters contributed by 35 authors who are specialists in the respective area of study concerned. About a third of the chapters deal with subject which were practically unknown 20 years ago.

In the prefatory chapter, Prof. Hoytink reviews the development of physical chemistry in the Netherlands from Van't Hoff to the present, with an accent on men who have contributed to this development. In the chapter on "Excited States and Reactions in Liquids", J. K. Thomas brings out the advances and contributions made by new techniques such as lasers and pulsed accelerators to practical studies and theoretical understanding of the nature of excited states in the liquid phase. In another chapter, J. C. Dalton and N. J. Turro review the recent studies on the photoreactivity of $n\Pi^*$ excited states of alkyl ketones. In a short chapter on "Potential Energy Surfaces", M. Krauss reviews the *ab initio* calculations of energy surfaces primarily of concern in Collisional and Chemical Kinetics Phenomena.

Recent developments in methods of spectroscopy are reviewed in four chapters "Microwave Spectroscopy" by H. D. Rudolph, "Photoelectron Spectroscopy" by D. W. Turner, "Vibrational Spectroscopy" by John Overand, and "NMR Spectroscopy" by Adam Allerhand and Elizabeth A. Trull. Benjamin Chu reviews selected topics on Laser Light Scattering with emphasis on Rayleigh Scattering and Brillouin Scattering.

The review article on "Detonation" by S. H. Lin and H. Eyring is concerned with the theory of detonation of condensed explosives. The chapter on "High Temperature Chemistry" by J. W. Hastie, R. H. Hauge and J. L. Margrave focuses attention on the molecular properties and in particular the thermodynamical stabilities and structures—geometrical, electronic and vibrational—of high temperature molecular species.

There are two chapters which review recent advances in the physical chemistry of polymers. They are "Polymer Conformation and Dynamics in Solution" by Marshall Fixman and Walter H. Stockmayer and "Optical Activity in Stereoregular Synthetic Polymers" by Piero Pino, Francesco Ciardelli, and Maurizio Zandomeneghi.

The other titles in this volume are : "Magnetic and Electric Effects on Transport Properties" by J. J. M. Beenakker and F. R. McCourt, "Equilibrium at Solid Surfaces" by G. D. Halsey Jr. and C. M. Greenlief, "Heterogeneous Catalysis" by P. B. Weisz, "Paraffin Pyrolysis" by D. A. Leathard and J. H. Purnell, "Intermolecular Forces" by A. D. Buckingham and R. D. Utting, "Elementary Gas Reactions" by Leonard D. Spicer and B. S. Rabinovitch, "Electrolytes" by R. H. Wood and P. J. Reilly, and "Electronic and Vibrational Excitons in Molecular Crystals" by G. Wilse Robinson. A. S. G.

Introduction to Partial Differential Equations—From Fourier Series to Boundary-Value Problems. By Arne Broman. (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London W. 1, England), 1970. Pp. 179. Price 79 *sh*.

Based on lectures given by the author and his colleagues for a course on the subject at the Chalmers University of Technology, Göteborg, Sweden, for over two decades, which have been continually improved upon from experience and discussions, this publication will serve as a useful text for undergraduate students of mathematics and physics taking this course. The book provides basic knowledge in Fourier Analysis and some of its applications. A background knowledge of calculus, linear algebra, ordinary differential equations, and complex analysis is expected as pre-requisite.

The subject-matter is covered in eight chapters, namely, Fourier series, Orthogonal systems, Orthogonal polynomials, Fourier transforms, Laplace transforms, Bessel functions, Partial differential equations of first order, and Partial differential equations of second order.

The text contains exercises, routine as well as advanced, at the end of each section. Teachers of the subject will find the book very useful.

A. S. G.

Fields and Waves in Communication Electronics. By S. Ramo, J. R. Whinnery and Theodore Van Duzer. (Wiley Eastern Private Ltd., J 41, South Extension 1, New Delhi-49), 1970. Pp. 754. Price Rs. 22·50.

This popular text-book for students of communications engineering is now made available as a low cost edition in India, published with the assistance of the Joint Indian-American Text-book Programme.

The present book is based upon the authors' older and well-known text, *Fields and Waves in Modern Radio*. But it has been modernised and updated, and it will serve as an intermediate level text for junior and senior courses.

A. S. G.

NMR Spectroscopy in Organic Chemistry. By B. I. Ionin and B. A. Ershov. (Plenum Publishing Corporation, 114, Fifth Ave., New York, N.Y. 10011, U.S.A.), 1970. Pp. 382, Price $ 25.00.

This book is the English translation of the original Russian text by the authors first published in 1967.

High-resolution nuclear magnetic resonance spectroscopy is becoming an essential physical method in organic chemistry for structural and physicochemical studies of organic compounds. Rapid developments in instrumentation technology have made high resolution spectra possible and this combined with refinements in theory has extended the range of application of this technique. Literature on the subject is growing and there is a large accumulation of experimental data on the correlation of NMR parameters like chemical shifts, spin-spin splitting, etc., with the structure of molecules. Essentially, NMR spectroscopy has become an independent field of physical organic chemistry with promise of its application to organic substances containing magnetic isotopes other than hydrogen and fluorine.

The book under review provides a valuable introduction to the subject. The first chapter treats with the fundamentals of NMR method and the three subsequent chapters go into a deeper analysis of the method dealing respectively with Chemical Shift, Spin-Spin Coupling, and Analysis of Complex NMR Spectra. The last two chapters are devoted to the various applications of NMR spectroscopy in organic chemistry. The appendix gives examples of NMR spectra of characteristic compounds dealt with in the text.

A. S. G.

Abelian Varieties. By David Mumford. (Published for the Tata Institute of Fundamental Research, Bombay, Oxford University Press, Bombay-1), 1970. Pp. 242. Price Rs. 60.

This book is based on a series of lectures delivered in the winter of 1967-68 at the Tata Institute of Fundamental Research, Bombay. It gives a systematic account of the basic results about abelian varieties. It includes an exposition of the analytic methods and results applicable when the ground field is the complex field **C**, and also of the scheme-theoretic methods and results used to deal with inseparable isogenies when the ground field k has characteristic p. A self-contained proof of the existence of a dual abelian variety is given. The structure of the ring of endomorphisms of an abelian variety is discussed.

The material is arranged under the following chapter headings: I. Analytic Theory; II. Algebraic Theory *via* Varieties; III. Algebraic Theory *via* Schemes; and IV. Hom (X, X) and the l-adic Representation.

A. S. G.

Books Received

Advances in Experimental Medicine and Biology, Vol. 8. *Bradykinin and Related Kinins*. Edited by F. Sicuteri, M. Rochae Silva, Nathan Back. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xxv + 651. Price $ 27.50.

Ageing in Cell and Tissue Cultures. Edited by E. Holeckova and V. J. Cristofalo. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xx + 163. Price $ 12.50.

Advances in Cryogenic Engineering, Vol. 15. Edited by K. D. Timmerhavs. (Plenum Publishing Corporation, 227, West 17th Street, New York, N.Y. 10011), 1970. Pp. xi + 484. Price $ 27.50.

Chemistry of the Ionosphere. By A. D. Danilov. (Plenum Publishing Corporation, 227, West 17th Street, New York, N.Y. 10011), 1970. Pp. xv + 296. Price $ 22.50.

2504-71. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.

ERADICATION AND UTILIZATION OF WATER HYACINTH—A REVIEW

ARCHANA SHARMA
University of Calcutta, 35, Ballygunj Circular Road, Calcutta-19

AN organism often propagates explosively when transplanted to a new environment. *Eichhornia crassipes* L., the water hyacinth, is an outstanding example in the South-East Asia, the Nile and the Congo basins, where, from an ornamental introduced less than a century ago, it has become a curse.[1-4] The problem of its eradication has formed the topic for symposia, researches, articles and even legislations for more than four decades, without a suitable formula having been evolved. Pleas for reorientation of ideas, to regard it as a crop rather than a pest and to find uses for it have been voiced amongst others, by Pirie,[5,6] Little[7] and also by the Food and Agriculture Organization of the United Nations (1968).[8]

Though exact figures as to the area covered by this weed in India are not available, yet the approximate figures from West Bengal (30,000 acres) and Bihar (200,000 acres) indicate the extent of its distribution. Gratch,[16] including the affected areas in Assam, Eastern U.P., Andhra Pradesh, Madras, Orissa and Kerala, estimated the total acreage under its domain to be about 500,000 acres. The adverse effects of such uncontrolled growth on agriculture, fisheries, transport and human health are obvious and the necessity for its extermination was felt early in this century, as the reports of the different advisers to the Government of India show.

The extermination of a weed involves its collection, subsequent disposal and prevention of further growth. Water hyacinth, being aquatic, is easy to collect, by manual labour or by mechanical appliances. Its disposal is more difficult as due to its high water content, it takes some time to dry before it can be burnt. Most difficult of all is prevention of further growth since the seeds remain dormant for at least one year and maintain their viability for several years. The plants are themselves able to resist considerable drought upto 5·7% of the saturated value of the water content of soil due to corresponding change in osmotic strength, decrease in the ratio of total leaf area to total root length and to the presence of mucilage at the leaf-base. The plant produces long roots with the progressive drying of the mud and thrives at the pH range between 6·0 and 8·0.[9] Further, since seeds lying at the bottom of the tank cannot germinate in the absence of oxygen, keeping the tanks flooded, presents a possibility of preventing their germination. Chemicals, both organic and inorganic, with lethal effects have been discovered, lethal dose for aq. copper sulphate solution being 0·018%. Spraying with chemicals is not consistently effective, since calcium oxalate crystals escaping from disintegrating leaves antagonise the effect of copper sulphate. Other chemicals had also a rather limited effect. In fact, the inevitable conclusion arrived at by certain earlier scientists, including Sir J. C. Bose[10] and P. Parija[9] was that the only effective means of controlling this weed was in its mechanical collection and destruction.

The magnitude of the spread of the plant makes its extermination, either by physical or chemical methods, a costly and painstaking process, which has to be repeated annually for an indefinite period—a burden poorer nations are hardly equipped to support. Attention was then diverted to finding a use for this plant, so that its eradication would entail some financial returns and a wide variety of works has been carried out.

The manifold uses to which the plant has been put include principally, (*i*) as fertilizer, compost and mulch, (*ii*) as fodder, silage and food for pigs, cattle, sheep and fish, (*iii*) in providing raw materials for industry, and (*iv*) as protein source and source for other chemicals.

I. Use as Fertilizer, Compost and Mulch—The fresh plant contains approximately nitrogen, 0·04 ; ash, 1·0 ; P_2O_5, 0·06 ; K_2O, 0·20 ; organic matter, 3·5 and moisture 95·5%. The corresponding proportion per dry weight is organic matter, 75·8 ; nitrogen, 1·5 ; ash 24·2%. The ash is found to have K_2O, 28·7 ; Na_2O, 1·8 ; CaO, 12·8 ; Cl. 21·0 ; P_2O_5, 7·0%.[11] The potash content increases with the size of the plant, being maximum in September and October. These figures show that the plant has a rather high NPK content and its potential value as a source of these elements cannot be ignored. As a fertilizer, the plant may pigment by organic solvent, purification through chromatographic separation, concentration, recovery of the solvent and storage. The carotene yield is 134·6 to 146·7 mg. per 3 kg. of fresh leaves, recovery being 84·0% to 87·9%.

Day,[39] after a detailed analysis of the plant as a source of potash, suggests that since 3% of the dried plant is potash (or 5% KCl), it can be recovered commercially from the plant by burning, lixiviation and fractional crystallization. Amongst certain tribes in Brazil, the ashes are leached in water and evaporated by boiling to give potash or KCl in a crude form.[40]

Pirie[5] suggested that since water hyacinth produces a pure stand with a luxuriant growth, it resembles a crop and advocated its use in human welfare, production of leaf-protein being one of the possibilities. Another report by the same author[6] summarizes the progress on this aspect in different centres. The conclusions of J. F. Catchpool, regarding the extraction of protein from populations growing in the delta of San Joachim river, indicate that the lack of mucilage favours the extraction, the plants can be ground easily in a waste disposal plant homogenizer and the addition of water is not necessary for extraction. The dried plant has 15%, the roots 12% and the leaves 30% protein as calculated from the nitrogen content. As the pH of the plant is 5·5, regrinding the pulp at pH 8·0 gives a better yield of protein in the juice. D. H. Samuel from Coimbatore reported that 42% of the nitrogen appear in the coagulated juice showing that protein forms 10% of the dry leaf weight. Pirie himself[41] found that protein extraction in water hyacinth is easier due to the high water content and palatability of the extracted protein was reported by Guha.[42] Mukhtar[43] estimates the amount of crude protein to be 5·30% to 5·70% and of crude fibre to be 19–22% of air-dried weight.

Oyakawa *et al.*[44] showed promising possibility of using water hyacinth in the manufacture of yeast. Each kg. of fresh plant yields 12 gm. of pure dried yeast with 52·7% protein and also 42 gm. of a mixture of yeast and bagasse with about 28% protein. The protein obtained can be classified, according to its analytical value, between egg protein (100%) and leguminous protein (50%) with an average of 87%. The yeast cream made from the extract has an agreeable odour and flavour, fit for human consumption. Datta *et al.*[45] extracted leaf protein from water hyacinth through crushing, mixing with a 3-fold weight of sodium carbonate (2%) for 30 min., centrifugation, precipitation by HCl and subsequent coagulation by heating to 80° C. A pH of 3·5–3·8 resulted in 96% precipitation of protein.

A series of experiments was devised by Sircar and his colleagues[46-48] on water hyacinth roots. Growth substances were separated from the extract by paper chromatography and it was seen that, in addition to indole compounds or gibberellins, other substances are present in water hyacinth root extract which show marked growth-promoting activities on both root and shoot of rice seedlings. The promoting activity of the extract was additive to gibberellic acid on rice growth and was better than the latter on the yield and the percentage of rice and gram grains. In gram and groundnut, gibberellic acid did not produce any acceleration of shoot growth but the extract of water hyacinth root gave increased height of both these plants.

Sheikh *et al.*[49] reported that extract of water hyacinth enhanced growth of micro-organisms like *Rhizopus, Saccharomyces* and of plants like varieties of *Phaseolus mungo* and accelerated alcoholic fermentation. From analytical studies, they suggest that organic substances have no effect and the inorganic ones are responsible for the enhancement of growth.

These varied uses of *Eichhornia crossipes* strengthen its claim to be regarded as a crop and its eradication can be a profitable proposition, if plants, on collection, can be suitably employed. Financial outlay is moderate and it can be undertaken either by state or private enterprises. The tanks, thus freed, can be sown with seedlings of *Trapa natans*, raised separately in nurseries. The vegetative growth of this plant is maximum during the rains and the fruits which are edible, are picked from October to January. Yield of the fruit per acre may be as high as 150 mds.[50] Persistent removal of water hyacinth followed by sowing with *Trapa natans* or *Lotus* sp. for a few successive years would soon result in the replacement of the water hyacinth populations by the latter plants and lead finally to its extermination or controlled growth.

---

1. Bose, P. K., *Sci. & Cult.*, 1945, **11**, 167.
2. Gay, P. A., *Nature*, 1958, **182**, 538.
3. — and Berry, L., *Geographical J.*, 1959, **125**, 89.
4. Davies, H. R. J., *Nature*, 1959, **184**, 1085.
5. Pirie, N. W., *Ibid.*, 1960, **185**, 116.
6. —, In *Handbook of Utilization of Aquatic Plants*, FAO Publications, PL : CP/20, Rome, 1968.
7. Little, E. C. S., ed., *Ibid.*, FAO Publications, PL : CP/20, Rome, 1968.

8. FAO Publications, *Ibid.*, PL: CP/20, Plant Production and Protection Division, Food and Agriculture Organization of the United Nations, Rome, ed., E. C. S. Little, 1968.
9. Parija, P., *Ind. J. Agric. Sci.*, 1934, **4**, 399.
10. Bose, Sir J. C., *Trans. Bose Inst.*, 1928, **3**, 786.
11. Finlow, R. S. and McLean, K., *Water Hyacinth and its [illegible]*, Govt. Printing Press, Calcutta, 1917, p. 16.
12. Howard, Sir Albert, "Water Hyacinth and its utilization," *Capital*, Calcutta, 1925, **54**, 1367.
13. Watson, E. F., *Indian Farming*, 1947, **8**, 29.
14. Basu, N. C., *Bull. Dept. Agric., Bengal*, 1937.
15. Basak, M. N., *Report*, West Bengal Govt. Press, 1948.
16. Gratch, H., *Rep. FAO Fisheries Adviser*, India, 1960.
17. Dhar, N. R., *Proc. Nat. Acad. Sci., India*, 1963, **33 B**, 16.
18. Anonymous, *[illegible]*, 1966, **13**, 31.
19. C.S.I.R., New Delhi, *The Wealth of India*, 1952, **3**, *Raw Materials*, p. 130.
20. Chatterjee, I. B. and Hye, M. A., *Agric. and Live-Stock in India*, 1938, **8**, 547.
21. Hossain, W., *Agric. Pakistan*, 1959, **10**, 513.
22. Agrupis, F. M., *Philip. Agric.*, 1953, **37**, 50.
23. Ramarokoto, M. R., *Working Paper No. WH/4*, FAO Conference on Quelea and Water Hyacinth Control in Douala, Africa, 1965.
24. Anonymous, *Madras Agric. J.*, 1951, **38**, 27.
25. Loosli, J. K., Belmonte, R. F., Villegas, V. and Cruz, E., *Philip. Agriculturist*, 1954, **38**, 146.
26. Smetana, P., *Report to the Government of Burma by FAO Poultry Expert*, Burma, 1967.
27. Villadolid, D. V. and Bunag, D. M., *Phil. Fish Year Book*, 1953, pp. 80, 241.
28. Ark, Sobaiti, *Agric. Pakistan*, 1959, **10**, 122.
29. Mahmud, E. A. B., In *Handbook of Utilization of Aquatic Plants*, FAO Publications, PL: CP/20, Rome, 1968.
30. Fischer, H. and Devencha, C., *Working Paper No.* 15, FAO Meeting of Pig Diseases and Production in Developing Countries, Singapore, 1963.
31. Hora, S. L., *Sci. & Cult.*, 1951, **17**, 231.
32. Azam, M. A., *Ibid.*, 1941, **6**, 6[illegible]6.
33. Gloor, A. M. and Gloor, R. P., *Chem. Abst.*, 1950, **47**, 12816.
34. Grist, D. H., *Rice*, Longmans, Green and Co., London 4th ed. 1959, p. 2[illegible]3.
35. Sen, H. K., Pal, P. P. and Ghosh, S. B., *J. Ind. Chem. Soc.*, 1929, **6**, 673.
36. — and Chatterjee, J., *J. Ind. Chem. Soc.*, 1931, **8**, 1.
37. Hackett, P. M. S. *et al.*, *Research*, 1952, **5**, 522.
38. Neogi, S. and Rajagopal, K., *J. Sci. Ind. Res.*, 1949, **8 B**, 119.
39. Day, F. W. F., *Agric. Bull. F.M.S.*, 1918, **6**, 309.
40. Schultz, B., *National Geographic*, 1962, **121**, 118.
41. Pirie, N. W., *Ann. Rev. Plant Physiol.*, 1959, **10**, 33.
42. Guha, B. C., *Lancet*, 1960, **1**, 705.
43. Mukhtar, A. M. S., *Sudan J. Vet. Sci. and Animal Husbandry*, 1967, **8**, 124.
44. Oyakawa, N., Olandi, W. and Valente, E. O. L., *Pro. IX Internat. Grassland Congr. Brazil*, 1965, **2**, 1707.
45. Datta, R. K., Chakrabarty, P. R., Guha, B. C. and Ghosh, J. J., *Sci. & Cult.*, 1966, **32**, 247.
46. Sircar, S. M. and Chakraverty, R., *Ind. J. Plant Physiol.*, 1962, **5**, 1.
47. Sircar, S. M. and Kundu, M., *Physiol. Plant.*, 1960, **13**, 56.
48. — and Ray, A., *Nature*, 1961, **190**, 1213.
49. Sheikh, N. M., Ahmed, S. A. and Hedayetullah, S., *Pakistan J. Sci. Ind. Res.*, 1964, **7**, 96.
50. Malik, H. C., *Indian Farming*, 1961, **11**, 23.

AVIAN ENCEPHALOMYELITIS

G. C. MOHANTY, B. S. RAJYA AND R. L. SAH

Division of Pathology, Indian Veterinary Research Institute, Izatnagar, Bareilly, U.P.

INTRODUCTION

AVIAN ENCEPHALOMYELITIS (AE) is a viral disease characterised by leg weakness, incoordination, ataxia and tremors, especially of head and neck, generally affecting chicks of 1 to 3 weeks old. Besides chickens, pheasants are also susceptible. The disease can be experimentally produced in ducklings, young turkeys, pigeons and game birds (Van Roekel, 1965). The disease was first described by Jones (1932) in the U.S.A. followed by its occurrence in various parts of the globe. Rao (1965) and Mathur and Mukerji (1967) mentioned the occurrence of AE in India and suspected the presence of infection on clinical manifestation.

The present communication deals with the patho-anatomy of AE in natural and experimental chicks.

MATERIALS AND EXPERIMENTAL PROCEDURE

The source of infected materials was from day-old White Leghorn chicks received by a private farm. These chicks exhibited signs of illness and mortality, starting from second day of their arrival. Twenty chicks (a few of them were dead) were submitted to the pathology division for diagnosis. More birds were received from the same farm during the first week, second week and third week of April 1970. For experimental transmission, day-old chicks from a separate farm without any history of this disease were used. A 10% saline brain suspension was made from infected chicks and intracerebrally inoculated into day-old and one-week-old chicks. Tissues from different regions were fixed in 10% formal-saline and processed for routine hematoxylin and eosin staining (H & E).

RESULTS

Clinical signs.—The main symptoms comprised of incoordination, bilateral ataxia with or without association of tremors in naturally infected cases (Fig. 1). Experimentally, clinical signs were produced after an average incubation period of 10 days (9-19 days) and comprised of incoordination, leg weakness and bilateral ataxia. Tremors of head and neck were occasionally associated with incoordination and ataxia but usually followed incoordination and ataxia. In a few instances the tremors were well marked and gradually decreased after 70 days post-inoculation (DPI). Mortality rate was low varying from about 10% to 21% of inoculated birds and usually occurs during 6 to 10th DPI. Number of chicks (day-old) showing clinical signs of the disease increased with serial passages (Table I).

TABLE I

Experimental transmission trials of AE

Passage No.	No. of chicks inoculated	Age of chicks in days	No. of chicks with clinical signs	Incubation period (DPI)
I	32	1	7	20
II	22	1	11	10-18
III	30	7	9	13-17
IV	25	1	17	9-30
V	10	1	7	9-19
VI	38	1	31	10-25
VII	21	1	21	8-23

Patho-anatomic changes.—No gross abnormalities were encountered in natural as well as in experimentally infected cases. Histopathological examinations of visceral organs of chicks from natural cases died during the first week of their life, revealed mild lymphocytic infiltration in a few birds. Microscopic examination of different regions of the brain and spinal cord showed presence of acute neuronal necrosis, especially marked in the region of pons-medulla and lumbar segments of the spinal cord (Fig. 2). Occasional areas of perivascular cuffings (Fig. 3) with lymphocytes and focal areas of gliosis were evident in a few cases.

Chicks examined after first week of their life with signs of pronounced leg weakness and ataxia exhibited moderate to marked infiltration of lymphocytic cells in the proventriculi and gizzard musculature, pancreas, heart, liver and kidneys. Lesions in the central nervous system (CNS) consisted of acute neuronal necrosis, areas of gliosis and perivascular cuffing. Perivascular cuffings were more pronounced in the brain whereas acute neuronal necrosis was prominent in the ventral horn of the spinal cord, especially in the region of lumbar spinal cord, just anterior to rhomboidal sinus.

Histopathological examinations of experimentally infected chicks revealed typical lesions in the CNS (Fig. 4) and visceral organs characteristics of AE. Lesions in the CNS (Figs. 5, 6) were more pronounced than those seen in visceral organs. Inoculated chicks without clinical signs showed CNS lesions but mild visceral lesions when destroyed at variable periods between 15 and 25 DPI. Initially lesions of AE were evident in brain as early as 5 DPI, *i.e.*, prior to the development of clinical signs.

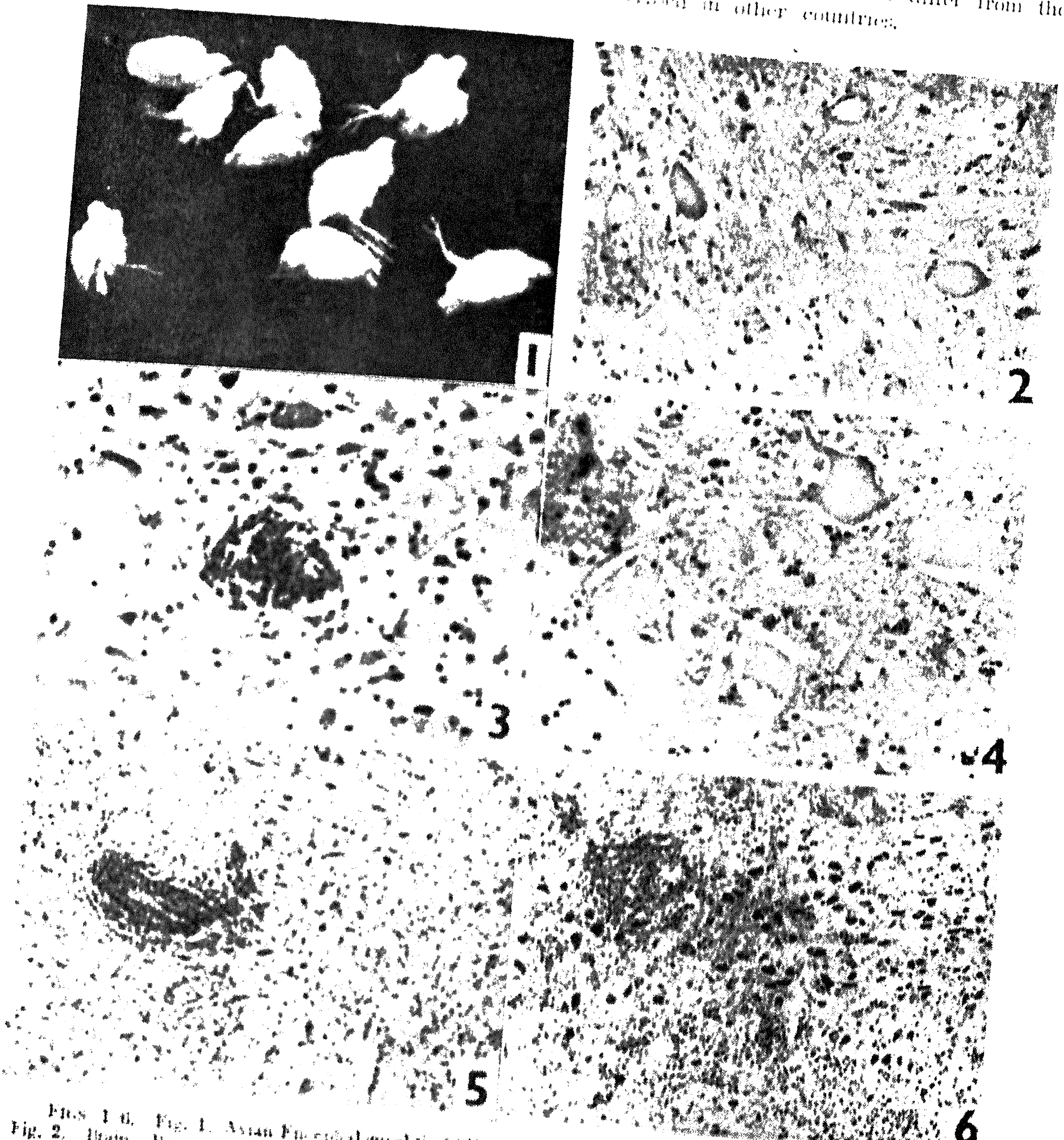
A few birds destroyed after prolonged illness (54 and 113 DPI) revealed an occasional glial nodule in brain or spinal cord. Lymphoid foci were seen only in gizzard musculature, pancreas and in heart musculature.

DISCUSSION

The patho-anatomical changes in the CNS and visceral organs were indistinguishable from those described by various workers (Springer and Schmittle, 1968; Mohanty and West, 1968; Butterfield *et al.*, 1969) for natural and experimental cases of AE. Tremors seen in experimentally inoculated cases usually developed after the onset of leg weakness, which indicates the late involvement of cerebellum. Histopathological changes in the cerebellum were suggestive of late involvement of this region. Mohanty and West (1968) observed similar changes in the cerebellum of experimentally infected chicks. Appearance of clinical signs within first week of the life of chicks in natural cases suggest egg transmission of the infection (Taylor *et al.*, 1955), whereas variable incubation period in experimental cases corroborates our present findings in natural and experimental cases (Mohanty and West, 1968). Histopathological lesions in visceral organs in natural cases were more pronounced than experimental cases, while lesions in the CNS were more prominent in experimental cases. Butterfield *et al.* (1969) and Mohanty and West (1968) recorded similar finding in natural and experimental cases of AE.

SUMMARY

An outbreak of Avian Encephalomyelitis (AE) was recorded in a private farm affecting young chicks. Subsequent laboratory studies confirmed the disease on clinical, pathological and virological studies. The manifestations of the disease do not differ from those described in other countries.



FIGS 1-6. Fig. 1. Avian Encephalomyelitis (AE) affected chicks (natural cases) showing bilateral ataxia. Fig. 2. Brain, Pons region of a natural case showing acute neuronal necrosis. H & E, × 260. Fig 3. Lumbar region of spinal cord from a natural case of AE chick showing an area of perivascular cuffing with lymphocytes. H & E, × 260. Fig 4 Lumbar region of spinal cord from an experimentally inoculated chick with acute neuronal necrosis (13 days post inoculation). H & E, × 310. Fig. 5. Lumbar segment of spinal cord from an experimentally inoculated chick showing an area of perivascular cuffing with lymphocytes (20 days post-inoculation). H & E, × 120. Fig. 6. Brain, Pons region of an experimentally inoculated chick showing areas of perivascular cuffing and gliosis (17 days post-inoculation). H & E, × 90.

ACKNOWLEDGEMENTS

The authors acknowledge with appreciation the encouragement and technical facilities provided by Dr. C. M. Singh, Director, Indian Veterinary Research Institute, Izatnagar, Bareilly, U.P. Technical assistance of Mr. Sartaj Bahadur is duly acknowledged.

---

1. Butterfield, W. K., Helmboldt, C. F. and Luginbuhl, R. E., *Avian Dis.*, 1969, **13**, 53.
2. Jones, E. E., *Science*, 1932, **76**, 331.
3. Mathur, R. P. and Mukerji, P. C., *Poult. View*, 1967, **1**, 9.
4. Mohanty, G. C. and West, J. L., *Am. J. Vet. Res.*, 1968, **29**, 2387.
5. — and —, *Avian Dis.*, 1968, **12**, 689.
6. Rao, S. B. V., *Ind. Poult. Gazette*, 1965, **48**, 116.
7. Springer, W. T. and Schmittle, S. C., *Avian Dis.*, 1968, **12**, 229.
8. Taylor, L. W., Lowry, D. C. and Raggi, L. G., *Poult. Sci.*, 1955, **34**, 1036.
9. Von Roekel, H., *Diseases of Poultry*, The Iowa State University Press, Ames, Iowa, 1965, 5th Ed., p. 771.

NUTRITIONAL QUALITY OF SOME POPULAR RICE VARIETIES

P. RAGHAVAIAH, V. P. AHUJA, A. K. KAUL AND M. S. NAIK
Genetics Division, I.A.R.I., New Delhi-12

In the last twenty years, rice production in India has increased from 21 million tonnes in 1951 to 39 million tonnes in 1965. The projected figure for 1971–72 is between 48–50 million tonnes. Only 17% of increase in the production has been attributed to an increase in area and the rest has been assigned to the increased production through better agronomic practices and the use of superior high-yielding photoinsensitive varieties.[1]

Until very recently, Indian yields of rice per acre were among the lowest in the world. The first and foremost drawback was the plant-type itself. The subspecies *indica*, the traditional type of rice grown in Indian conditions, is characterised by tall growth habit, profuse number of narrow light-green drooping leaves, delayed flowering and late maturity. Though ideally suited to cloudy and rainy season, it succumbs to the modern high fertility farming. Additional fertilizer results in rapid vegetative growth and profuse leafing. These additional leaves mutually shade the plants and lead to the decreased photosynthetic efficiency in accumulating the carbohydrates. The plant-type bottle-neck to higher yields has been broken through algeny[2] and now we have a rice plant that is photoinsensitive, erect, short, has high capacity of tillering, matures early and possesses wide, dark and green leaves that remain photosynthetically active right upto the grain-filling stage. Twin characters of non-lodging and reduced mutual shading of the leaves have enabled it to stand very heavy doses of fertilizers to produce very high yields. It is in the background of this plant-type that the nutritional aspects of the present and future rice varieties should be discussed. The composition of rice differs with plant-type, variety, soil conditions, manuring, location, soil moisture and weather conditions prevalent at the time of grain filling. A systematic investigation on these factors has just begun.[3] Quantitative as well as qualitative characters are being considered in this context. From the studies, so far conducted, it could be concluded that among the above-mentioned factors, the genotype of the strains is most important.[4]

In the present study, an attempt was made to compare six popular rice varieties for their protein, carbohydrate and amino-acid composition. The length/breadth ratio and swelling number was also obtained to assess the cooking quality of these varieties. The data are presented in Tables I and II. In Table II, the reference aminogram for rice has been taken from Eggum (1968) for comparison.[5] It is clear from the figures presented that with reference to protein content, there is significant difference between two distinct sets of varieties. Varieties Basmati-370, Sabarmati and Hamsa are having roughly 2% higher protein than Padma, Jaya and IR-8. These differences have been clearly discriminated by D.B.C., as well as microkjeldahl estimation. The starch properties as reflected by the amylose content are not widely different. However, if cooking quality is judged on the basis of swelling number and L/B ratio, it is evident that Sabarmati and Hamsa are similar to Basmati-370, therefore highly acceptable.[6] Varieties Padma, Jaya and IR-8 seem to be inferior on the basis of these two criteria.

TABLE I

Quality characters of some important rice varieties (On 10% moisture basis)

S. No.	Variety		1000 kernel weight	Protein %		[illegible] value (A.S.)	Amylose %	Swelling number*	Length/Breadth	
				Kjel.	[illegible]				Before cooking	After cooking
1	Basmati 370	..	16·2	10·5	10·2	0·22	24·0	375	4·0	5·3
2	Sabarmati	..	14·2	10·8	10·2	0·22	23·5	329	3·0	3·3
3	Hamsa	..	18·2	10·7	10·2	0·22	27·0	328	3·5	3·4
4	Padma	..	16·1	8·6	8·7	0·19	26·5	315	2·7	2·7
5	Jaya	..	22·0	8·0	8·1	0·19	27·0	299	2·1	2·3
6	IR-8	..	19·5	8·0	8·1	0·18	25·7	293	2·2	2·4
	Mean	..	17·7	9·43	9·25	·206	25·6	324·2	2·92	3·21
	Standard deviation	..	2·8	1·32	1·06	0·02	1·52	29·2	0·74	1·10

* Weight of water in grams absorbed by 100 gm of rice cooked at 98° C.

TABLE II

Amino acid composition of six rice varieties (gm. amino acid/16 gm. N, calculated to 100% recovery)

Amino acid		Basmati 370	Sabarmati	Hamsa	Padma	Jaya	IR 8	Eggum (1968)
Aspartic acid	..	7·84	9·74	9·18	10·38	10·83	8·13	8·23
Threonine	..	3·82	4·16	3·71	4·41	4·36	4·05	3·25
Serine	..	6·40	8·01	7·99	6·41	6·61	7·08	4·40
Glutamic acid	..	[illegible]·54	20·48	23·09	22·74	20·50	22·06	17·18
Glycine	..	5·[illegible]0	8·46	7·33	6·[illegible]8	6·86	6·24	3·88
Alanine	..	5·67	8·87	8·11	6·95	7·06	6·04	5·11
Valine	..	6·34	8·69	4·82	6·29	6·28	6·[illegible]4	5·43
Cystine	..	[illegible]·64	2·5[illegible]	2·19	2·83	2·61	2·04	1·30
Methionine	..	1·33	[illegible]	1·[illegible]6	2·32	2·48	2·40	2·07
Isoleucine	..	4·[illegible]2	5·02	4·28	5·02	5·49	4·45	1·46
Leucine	..	9·93	7·26	9·10	8·36	8·90	7·40	7·95
Tyrosine	..	4·19	4·64	4·69	3·76	3·98	2·82	5·0[illegible]
Phenylalanine	..	3·65	6·24	5·11	5·43	4·04	[illegible]·02	5·22
Lysine	..	[illegible]	4·[illegible]	[illegible]	4·30	4·21	3·01	3·49
Histidine	..	2·19	2·[illegible]2	2·24	[illegible]	2·87	2·03	2·24
Arginine	..	7·68	5·77	6·53	8·18	8·11	6·87	7·81
Tryptophan	..	0·99	1·07	1·12	1·05	0·82	0·92	0·60
Actual recovery %	..	97·0	101·0	90·1	96·5	97·9	89·0	..
E.A.A.I. %	..	[illegible]	[illegible]	[illegible]	85	84	[illegible]	..

Table II gives the amino acid content of all the rice varieties. When the essential amino acids were used to calculate the Essential Amino Acid Index (E.A.A.I.)[7], it was found that Sabarmati, Padma and Jaya are significantly superior to Hamsa, Basmati 370 and IR-8. The variety IR 8 stands lowest on the basis of this score. Since E.A.A.I. has been found to have a high positive correlation with the protein efficiency ratio (P.E.R.)[8], it could be concluded that varieties Sabarmati, Padma and Jaya have comparatively high biological value than varieties Basmati-370, Hamsa and IR-8. Tables I and II are self-explanatory.

We are indebted to Dr. M. S. Swaminathan and H. K. Jain for their encouragement.

1. Parthasarathy, N., *Indian Farming*, Special Rice Number, Sept. 1966, p. 14.
2. Swaminathan, M. S., [illegible] *News Letter*, 196[illegible], **1**, 11.
3. —, Austin, A., Kaul, A. K. and Naik, M. S., *FAO/IAEA, Proceedings on New Approaches to Breeding for Improved Plant Protein*, 1969, p. 71.
4. Kaul, A. K., Naik, M. S., Dhar, R. D., Mehta, V. and Raghavaiah, P., *J. of Post-graduate School*, 1968, **6** (2), 148.
5. Eggum, B. O., *Aminosyrekoncentration og Protein-kvalitet*, Stougaards Forlag, København, 1968, p. 90.
6. Raghavaiah, P. and Kaul, A. K., *Indian J. of Genetics and Plant Breeding*, **30** (3) (Under publication).
7. Oser, B. L., *J. of the American Dietetic Association*, 1951, **27**, 396.
8. Eggum, B. O., *FAO/IAEA, Proceedings on New Approaches to Breeding for Improved Plant Protein*, 1968, p. 125.

LETTERS TO THE EDITOR

NEUTRON DIFFRACTION STUDY OF TRIGLYCINE SULFATE

TRIGLYCINE SULFATE $(NH_2CH_2COOH)_3.H_2SO_4$ exhibits ferroelectric properties at room temperature. The Curie temperature lies at 49° C. The phase above the transition has monoclinic symmetry and belongs to the centrosymmetrical class 2/m. Below the transition temperature, the mirror plane disappears and the crystal belongs to the polar point group 2 of the monoclinic system. A detailed determination of the structure of the crystal was made by Hoshino, Okaya and Pepinsky[1] at room temperature from full 3-D X-ray diffraction data. According to them, the chemical formula is properly written as $(NH_3^+CH_2COO^-)(NH_3^+CH_2COOH)_2SO_4^{2-}$ and the compound is best described by the chemical name glycine diglycinium sulfate. Out of the three glycine molecules in the crystal, one has the zwitter-ion configuration, with the $NH_3{}^+$group out of the plane of the other atoms ; the remaining two glycines are monoprotonated and planar within experimental error. However, from infra-red measurements of normal TGS Dodd,[2] Tinkham[3] and Sato[4] were doubtful of the existence of the zwitter ion in TGS. As proton position has not been determined, a single crystal neutron diffraction study was made to determine the positions of the hydrogen atoms, and thereby to verify the existence of the zwitter ion in the crystal.

Neutron diffraction data were collected for all the three zones (upto *sin* $\theta \leqslant 0 \cdot 80$) using spectrometer facility at the Cirus reactor (Chidambaram, Sequeira and Sikka[5]). A neutron wavelength of 1·03 Å was used. The spectrometer was of the θ-2θ setting and operated by step scanning at intervals of 0·1° in 2θ. Integrated intensities for 325 independent reflections along the three zones were obtained and these were converted to F by the usual methods. The systematic absences were found to be consistent with the space group $P2_1$. The cell parameters used in the analysis are those reported by Hoshino *et al.*

$a = 9 \cdot 41$, $b = 12 \cdot 64$, $c = 5 \cdot 73$ Å, $B = 110 \cdot 4°$ and $Z = 2$.

The positions of the hydrogen atoms were determined using the conventional Fourier synthesis and the data were subjected to several cycles of full matrix least squares refinement, with isotropic temperature factor for each atom. The final R factor was 0·11 and the refinement was stopped at this stage. The salient features of the study are as follows :

(*i*) The structure is essentially the same as that found in the investigation by Hoshino *et al.* from X-ray studies. The heavy atom co-ordinates agree well with those reported by Hoshino. As indicated by Hoshino, glycine ions II and III (after Hoshino's nomenclature) are connected by a short O–H......O bond with a distance 2·46 Å (between the oxygen of the carboxyl group of glycine II and that of the glycine III). The hydrogen atom is closer to the carboxyl group oxygen of the glycine III, agreeing with the asymmetrical position suggested by Hoshino. As suggested by Hoshino, glycine I is protonated and this hydrogen atom forms a hydrogen bond (of distance 2·57 Å) with the oxygen of the sulfate group. So the third is a zwitter-ion, thus confirming the findings of Hoshino *et al.*

(*ii*) The bond distances C–C, C–O and C–N of the glycine groups are in agreement with those reported in the literature.

(*iii*) The sulfate tetrahedron is distorted.

(*iv*) There are seventeen protons in the asymmetric unit. Nine protons are attached to nitrogens of the three glycine ions, forming NH_3 groups. The mean N–H bond distance is 1·01 Å (uncorrected for thermal motion) all of them form a network of N–H......O hydrogen bonds with N....O distances in the range 2·71–3·01 Å and N–H......O angles 132–180. Six protons are attached to three CH_2 groups and the mean CH distance is 1·03 Å. The mutual arrangement of NH_3 and CH_2 around the C–N axis for all three glycine is close to a staggered configuration. The remaining two hydrogens are attached to the oxygens of the carboxyl group of the two glycine ions forming O–H......O bonds as indicated above. The O–H bond distances in the two cases were 1·01 and 1·04 Å and the hydrogen bond angles O–H.....O were 170° and 151°.

Full details will be published elsewhere.

Nuclear Phys. Div., V. M. PADMANABHAN.
Bhabha Atomic Res. V. S. YADAV.
Centre, Trombay, Bombay-85,
November 16, 1970.

---

1. Hoshino, S., Okaya, Y. and Pepinsky, R., *Phys. Rev.*, 1959, **115**, 323.
2. Dodd, D. M., *Spectrochemica Acta.*, 1957, **15**, 1072.
3. Tinkham, M., *J. Chem. Phys.*, 1963, **38**, 2257.
4. Sato, Y., *Ibid.*, 1966, **45**, 275.
5. Chidambaram, R., Sequeira, A. and Sikka, S. K., *Ibid.*, 1964 *a*, **41**, 3616.

ON LIGHT TRACKS IN THE PRESENCE OF A MASSIVE BODY

THE null geodesics of the space-time metric external to a static spherically symmetric body are treated here for the case of a non-zero cosmological constant.

The general static spherically symmetric space-time metric can be written

$$-ds^2 = A(r)\,dr^2 + B(r)\,(d\theta^2 + \sin^2\theta\,d\phi^2) - C(r)\,dt^2 \tag{1}$$

where ds is the space-time interval and the co-ordinates are (r, θ, ϕ, t), (r, θ, ϕ) being spherical polars. The null geodesics of (1) have been investigated (using different notation) by Atkinson.[1] In particular, when $\dot{r} = 0$, with a dot denoting differentiation with respect to a scalar parameter p, it is found that

$$\frac{d^2r}{dt^2} = \frac{c^2C}{2A}\left(\frac{B'}{B} - \frac{C'}{C}\right) \tag{2}$$

where a dash denotes differentiation with respect to r. Equation (2) describes the nature of apses. If $\dot{r} = 0 = \ddot{r}$, corresponding to a circular null geodesic, then $B'/B = C'/C$. The time t_0 for a photon to describe such a circle is $(2\pi/c)(B/C)^{\frac{1}{2}}$, c being the speed of light. These results hold for an arbitrary metric of the form (1): they are independent of any field equations.[1]

For the metric (1), expressions for the components $G_\mu{}^\nu$ of the Einstein tensor can be obtained from the book by Synge.[2] In empty space, the field equations of general relativity, with cosmological constant Λ, are $G_\mu{}^\nu = \Lambda\delta_\mu{}^\nu$. The equations $G_1{}^1 - G_4{}^4 = 0$ and $G_4{}^4 = \Lambda$ integrate to:

$$A = (B')^2/4BC \tag{3}$$

and

$$A = \frac{(B')^2}{4B}\left(1 + \frac{\Lambda B}{3} - \frac{2m}{B^{1/2}}\right)^{-1} \tag{4}$$

where m is a constant; the constant of integration in (3) has been set equal to unity, without loss of generality. Elimination of A gives:

$$C = 1 + \frac{\Lambda B}{3} - \frac{2m}{B^{1/2}}. \tag{5}$$

These integrals generalize those of Atkinson,[1] who did not include the cosmological term.

Differentiating (5) logarithmically and substituting into (2) gives:

$$\frac{d^2r}{dt^2} = \frac{2c^2}{B^{3/2}\,B^1}\,(B^{1/2} - 3m)\,h\,(B) \tag{6}$$

where $h(B) \equiv \Lambda B^2/3 + B - 2mB^{\frac{1}{2}} = CB$. On a photon circle, $B^{\frac{1}{2}} = 3m$, corresponding to $C = 1/3 + 3\Lambda m^2$; also, $t_0 = (6\pi\sqrt{3}m/c)\,(1 + 9m^2\Lambda)^{-\frac{1}{2}}$.

The function B will be required to be real and positive and to increase monotonically with radial distance; m is real and positive. When $B^{\frac{1}{2}} = 3\,m$, $h(B) > 0$ if $\Lambda > -1/9m^2$; then t_0 is real, and a photon circle exists provided the central body has a radius less than that given by $B^{\frac{1}{2}} = 3m$. In the following it will be supposed that a photon circle exists.

The factor $(B^{\frac{1}{2}} - 3m)$ in (6) is positive outside the photon circle and negative inside it. The function $h(B)/B^{\frac{1}{2}}$ is positive on the photon circle and negative when B vanishes, so it must have a zero at B_1 where $0 < B_1^{\frac{1}{2}} < 3m$. The discriminant of the cubic function of $B^{\frac{1}{2}}$ in the equation:

$$h = \frac{1}{3}\Lambda B^{1/2}\left(B^{3/2} + \frac{3}{\Lambda}B^{1/2} - \frac{6m}{\Lambda}\right) \tag{7}$$

is $4(1 + 9m^2\Lambda)/\Lambda^3$. If $\Lambda > 0$, the cubic has only one real zero, while if $-1/9m^2 < \Lambda < 0$, there are three unequal real zeros. In the latter case, since $h(B)/B^{\frac{1}{2}}$ is negative for large positive $B^{\frac{1}{2}}$ and positive for large negative $B^{\frac{1}{2}}$, B_1 is the only zero of that function in $0 < B^{\frac{1}{2}} < 3m$, while it has a zero B_2 outside the photon circle.

Inside the photon circle $d^2r/dt^2 > 0$ or < 0 according as $B < B_1$ or $B > B_1$. Outside the circle, $d^2r/dt^2 > 0$ if $\Lambda > 0$, while if $-1/9m^2 < \Lambda < 0$, $d^2r/dt^2 > 0$ or < 0 according as $B < B_2$ or $B > B_2$.

So if $\Lambda > 0$, the nature of apses is essentially the same as when $\Lambda = 0$; in particular, finite non-circular orbits with minimum distances in $B^{\frac{1}{2}} < B_1^{\frac{1}{2}}$ and maxima in $B_1^{\frac{1}{2}} < B^{\frac{1}{2}} < 3m$ appear feasible. For such an orbit to exist, the time calculated for an arbitrary change to occur in the angular co-ordinate of a photon describing the orbit would have to be finite, real and positive. It should be noted that the feasible finite non-circular orbits all cross the apparent metric singularity at which $C = 0$ and hence, A is infinite.

If $-1/9m^2 < \Lambda < 0$, the non-zero value of Λ introduces a further apparent metric singularity B_2; for $B > B_2$, $d^2r/dt^2 < 0$ so apses there correspond to maximum distances; finite non-circular orbits, crossing one or both apparent singularities, are feasible. Investigation of the zeros of the cubic function of B in (7) shows that for $-\Lambda$ small, $B_2^{\frac{1}{2}} \doteqdot (-3/\Lambda)^{\frac{1}{2}}$. That is, $B_2^{\frac{1}{2}}$ is approximately independent of m and occurs at a large distance from the central object. On this scale, the situation becomes a cosmological one and should, more realistically, be treated by taking the central object to be embedded in distributed matter.

Dept. of Physics, R. Burman.
University of Western Australia,
October 12, 1970.

---

1. Atkinson, R. d'E., *Astron. J.*, 1965, **70**, 513 and 517.
2. Synge, J. L., *Relativity*: *The General Theory*, North-Holland, Amsterdam, 1960, pp. 270.

DIELECTRIC CONSTANT OF CERTAIN DIHYDROXY SOLIDS

The dielectric constant of resorcinol, hydroquinone and toluhydroquinone had been determined from measurements on powdered samples at 1 MHz using a co-axial cell of Barrer and Saxon-Napier type.[1] The cell designed and constructed with some modifications in our laboratory consists of two removable parts joined together by a ground glass joint. A Franklin Oscillator-Wavemeter combination of the type originally described by LeFevre, Ross and Smythe[2] was employed for the measurement of dielectric constant. The method of obtaining the dielectric constant of the massive solid (bulk dielectric constant) from measurements on powders had been described elsewhere.[3]

Resorcinol and hydroquinone are dihydroxy benzenes with the two OH groups in the *meta*- and *para*-positions respectively. Catechol, the *ortho*-compound in this series, could not be investigated as this was found to affect the silvering of the cell. Toluhydroquinone is *para*-dihydroxy toluene. Analar samples of the substances were initially ground into fine powders and were kept in a desiccator to avoid traces of moisture. Measurement of dielectric constant was carried out by completely filling the cell with the powdered samples.

The values of the dielectric constant are given in Table I.

TABLE I

Substance	Formula	μ Debye units	Dielectric constant
Resorcinol ..	$m\text{-}C_6H_4(OH)_2$	2·09	3·20
Hydroquinone	$p\text{-}C_6H_4(OH)_2$	1·40	2·96
Toluhydroquinone	$p\text{-}C_6H_3(CH_3)(OH)_2$	..	3·14

It may be seen from Table I that the value of dielectric constant of hydroquinone is less than that of resorcinol. This is in order considering the dipole moments of the two compounds (also included in Table I) reported by Lander and Svirbely.[4] The dipole moment (μ) of hydroquinone is less than that of resorcinol. The value of dielectric constant of toluhydroquinone is higher than that of hydroquinone but is lower than that of the *meta*-compound, resorcinol.

Two of us (B. S. R. and C. V. R.) are grateful to the C.S.I.R. for the award of a Senior Fellowship.

Dept. of Physics, B. S. Rajyam.
A.U.P.G. Centre, C. V. Ramasastry.
Guntur-5, C. R. K. Murty.
October 21, 1970.

---

1. Barrer, R. M. and Saxon-Napier, E. A., *Trans. Faraday Soc.*, 1962, **58**, 145.
2. LeFevre. R. J. W., Ross, I. G. and Symthe, B. M., *J. Chem. Soc.*, 1950, 277.
3. Ramasastry, C. V., Haranadh, C. and Murty, C. R. K., *Trans. Faraday Soc.*, 1967, **63**, 569.
4. Lander, J. J. and Svirbely, W. J., *J. Amer. Chem. Soc.*, 1945, **67**, 322.

CRYSTALLOGRAPHIC STUDIES IN THE SYSTEM $(1-X)La_3NbO_7 + X\,Sm_3NbO_7$

The structural properties of Weberite[1] and Fluorite[2] have been studied by many workers but their structural relationship has not yet been studied. In this note, the preparation and crystallographic studies of La_3NbO_7 (Weberite type) and Sm_3NbO_7 (Fluorite type) and their solid solutions are reported.

The pure compounds La_3NbO_7 and Sm_3NbO_7 and their solid solutions were prepared by the high temperature solid state reaction between the constituent oxides at 1,200° C. for 6 hr. All the X-ray examinations were made by a conventional powdered-crystal technique using

Ni filtered Cu Kα radiation and a camera of 14 cm. diameter.

La_3NbO_7 crystallises with the orthorhombic Weberite structure with $a_0 = 7{\cdot}82$ Å, $b_0 = 10{\cdot}84$ Å and $c_0 = 7{\cdot}71$ Å. Sm_3NbO_7 crystallises with the defect fluorite (cubic) structure with $a = 5{\cdot}36$ Å (10·72 Å if indexed on the basis of cubic pyrochlore type structure). Table I shows the variation of the unit cell dimensions with X.

TABLE I

Crystallographic data for $(1 - X) La_3NbO_7 + X\ Sm_3NbO_7$

X	Structure type*		Lattice parameters Å		
			Orthorhombic		
			a_0	b_0	c_0
0	W		7·82	10·84	7·71
20	W		7·78	10·88	7·65
40	W		7·72	10·92	7·58
60	W		7·68	10·96	7·53
80	P+W	W	7·66	10·98	7·52
		P	Cubic		
			Defect fluorite		Pyrochlore
			5·34		10·68
100	P		5·36		10·72

* W = Orthorhombic Weberite type, P = Cubic defect fluorite type (Pyrochlore type).

It is seen that the Weberite structure is retained for high values ($\geqslant 80$ mole%) of X. It is further seen that this structure expands in the b direction and contracts in the a and c directions with the increase in X. The strain, as denoted by b_0/a_0 increases with X. At a critical concentration $X \geqslant 80$ mole%, the lattice can no longer sustain the strain and transforms itself into cubic (defect Fluorite type) one. It may also be seen that the Weberite structure is stable for high radius ratio of A/B ($La^{3+} = 1{\cdot}22$ Å, $Sm^{3+} = 1{\cdot}13$ Å, and $Nb^{5+} = 0{\cdot}68$ Å).[3] This is in good agreement with the results of Aleshin and Roy.[4] A close geometric structural relation is easily deduced between the Weberite and pyrochlore type structures, since the former type cell is a relatively smaller one oriented at an angle of 45° about the b direction with respect to the cubic cell. If the a and c parameters of La_3NbO_7 which are nearly equal to one another are multiplied by $\sqrt{2}$ the resultant unit is nearly cubic with a parameter of about 10·80 Å. This cell is dimensionally equivalent to the cubic (in terms of the pyrochlore type) cell of Sm_3NbO_7 which has somewhat smaller cell dimension of 10·72 Å. On this purely geometric basis the Weberite type of structure may be described as orthorhombic distortion of the cubic pyrochlore type structure as experimentally established presently in going from La_3NbO_7 to Sm_3NbO_7.

Dept. of Physical and
Solid State Chemistry,
Institute of Science,
Nagpur, October 28, 1970.

O. B. THAKRE.
P. V. PATIL.
V. S. CHINCHOLKAR.

---

1. Byström, A., *Arkiv Kemi, Mineral. Geol.*, 1945, **18 A, 1.**
2. Roth, R. S., *Ceram. Abstr.*, November 1962, **273 *d*.**
3. Sidgwick, N. V., *Chemical Elements and Their Compounds*, Clarendon Press, Oxford, 1950, **1, 29.**
4. Aleshin, E. and Roy, R., *J. Am. Ceram. Soc.*, **1962, 45, 18.**

TIME SERIES IN BIOLOGICAL RHYTHM

PHYSICAL and mathematical models on time series in biological rhythms have been reviewed by Sollenberger.[1] Recently, Fort and Mills[2] have fitted sine curve to 24 cycle of urination: these models fit well with hourly observations on rhythm activities. When observations are made in block of time[3] or in phases such as in Williams' six diurnal phases,[4] angular transformation[5] is more appropriate in deciding the midpoints and group effects of the time blocks. An illustration is given with reference to the feeding rhythm of an iulid diplopod.

Defaecated adult diplopods were kept in groups of five at 23° C. with 90 ± 5% R.H. in constant darkness with pieces of rotten wood as food: there were five replicates. An estimate of the feeding activity was made from the number of excretory pellets produced at different time intervals: in preliminary studies, a positive correlation ($r = 0{\cdot}85$: $P \leqslant 0{\cdot}05$) was obtained between the feeding activity and the number of faeces produced. The data with the calculated parameters are shown in Table I.

The mean vector r was calculated as:

$$r = \sqrt{x^2 + y^2} = 0{\cdot}26$$

where

$$x = \frac{1}{n} \sum_{i=1}^{K} n_i \cos a_i = 0{\cdot}26$$

and

$$y = \frac{1}{n} \sum_{i=1}^{K} n_i \sin a_i = 0{\cdot}05.$$

Some deviation in the value of r can be expected if the group effect was stronger. The

TABLE I

Angular transformation of the data on feeding rhythm of an iulid diplopod at 23° C. with 90 ± 5% R.H. in constant darkness

Time interval	Arithmetic midpoint	Total no. of faeces produced n_i	$\cos \alpha_i$	$n_i \cos \alpha_i$	$\sin \alpha_i$	$n_i \sin \alpha_i$
14·00 – 4·00	2·30	306	+ ·7943	+ 243	+ ·6087	+ 187
4·00 – 8·00	6·30	161	− ·1256	− 21	+ ·9914	+ 160
8·00 – 12·00	10·30	141	− ·9238	− 131	+ ·3826	+ 54
12·00 – 16·00	14·30	73	− ·7943	− 58	− ·6087	− 44
16·00 – 20·00	18·30	210	+ ·1305	+ 28	− ·9914	− 208
20·00 – 24·00	22·30	253	+ ·9238	+ 234	− ·3826	− 97
		1148		+ 295		+ 56

correction (r_c) for the possible group effect is obtained from the relationship:

$$r_c = r \frac{\beta}{\sin \beta} = 0.27$$

where β is the half-group interval measured in radians. In the present example the value of the mean vector r and the corrected vector r_c closely agree indicating group effect was negligible. The mean angle θ is calculated as:

$$\cos \theta = \frac{x}{r} = 1{\cdot}00 \quad \text{or} \quad \frac{x}{r_c} = 0{\cdot}97$$

and

$$\sin \theta = \frac{y}{r} = 0{\cdot}19.$$

Using these parameters, the time factor corresponding to the mean angle is obtained from a table of measure of angles, which in the present example is 0·44 minutes. This is therefore the correction factor for the mean time relative to each time phase and is biologically more significant than the arithmetic midpoint. However, by using the solar time instead of the local time, still better approximation can be obtained.[6,7]

Tocklai Exptl. Station, BARUNDEB BANERJEE.
Jorhat-8, Assam,
October 23, 1970.

---

1. Sollenberger, A., *Biological Rhythm Research*, Elsevier, Amsterdam, 1965.
2. Fort, A. and Mills, J. N., *Nature*, 1970, **226**, 657.
3. Williams, G., *J. Anim. Ecol.*, 1959, **28**, 1.
4. Banerjee, B., *Oikos*, 1967, **18**, 141.
5. Batschelet, E., *Statistical Methods for the Analysis of Problems in Animal Orientation and Certain Biological Rhythms*, AIBS, Washington, 1965.
6. Banerjee, B. and Das, S. C., *Bull. Ent. Res.*, 1969, **59**, 371.
7. —, *Indian J. Ent.* (in press).

ASPHYXIA FROM CONGENITAL GOITRE IN NEW-BORN KIDS

SOME of the common causes of obstruction in the upper respiratory tract, recognised in the animals, have been oedema of larynx, accidental lodging of solid food in larynx, particle obstruction due to vocal cords as in 'roaring' in horses, etc. (Blood and Henderson[1]). Jubb and Kennedy[2] mentioned that excessive enlargement of thyroids, as in goitre, may cause obstruction in swallowing and respiration. In India, Lall[4] reported a case of birth of dead triplet kids having congenital goitre. In the present report a case of congenital goitre in new-born kids that were born alive and died subsequently as a result of respiratory distress is described.

On 30-1-1970 a *desi* goat gave birth to two male kids, which remained alive for about 20 minutes and thereafter died showing symptoms of respiratory distress and asphyxia. This was the third kidding of the she-goat and none of the kids born so far were reported to have shown such condition. The goat had expelled the placenta normally and was looking apparently healthy. The case along with the dead kids was brought to the veterinary clinic by the owner for advice.

No gross abnormality was observed in the kids except that they were devoid of hairs on the body. Only a few bunches of hair were present on the knees and the metatarsal region. On further examination two big symmetrical swellings on either side of the larynx compressing the trachea were observed (Fig. 1). The swellings consisted of enlarged thyroids the details of which are given in Table I.

TABLE I

Size and weight of the thyroids

Kid No.	Thyroid No.	Dimension cm.	Weight gm.
1	1	6·0 × 4·0	29·90
	2	6·5 × 4·0	36·00
2	1	6·0 × 4·0	36·80
	2	6·2 × 4·0	35·00

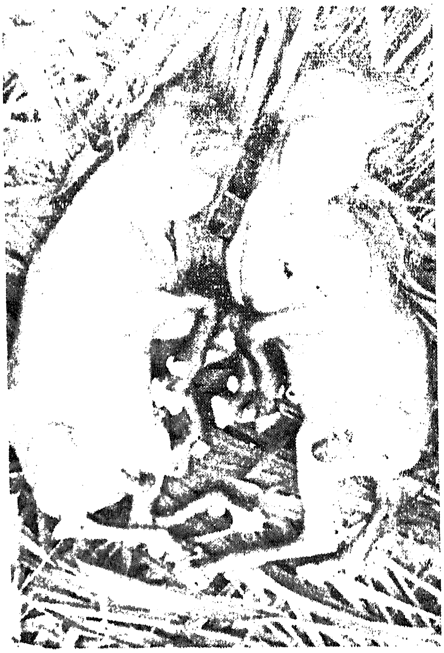


FIG. 1. Showing the enlarged thyroids in the new-born kids.

The blood-vessels in the region of neck, particularly the jugular veins, were very much engorged. The visceral organs were grossly normal and there was no evidence suggestive of any neoplastic growth or other abnormality.

Small pieces of tissue from the thyroids were collected, fixed in 10% formalin and were processed by the standard procedure of paraffin embedding. The sections 4-6 μ thick were cut and stained with haematoxylin and eosin method. The sections revealed the thyroid tissue consisting of acini lined with low columnar to cuboidal epithelium, containing deeply staining eosinophilic secretion, the colloid. No other changes suggestive of neoplastic growth were observed. The microscopic findings confirmed this to be a case of simple colloid goitre.

The kids in the present case were born alive but died after some time subsequently as a result of respiratory distress and suffocation. Cohrs,[2] Jubb and Kennedy[3] have also made similar comments. Blood and Henderson[1] have described the cardinal signs of iodine deficiency to include neonatal mortality with alopecia and palpable or visible enlargement of the thyroid glands. Wooldrige[6] described 10-20% mortality in kids due to goitre in some parts of Germany. Rajkumar[5] observed about 31% (25 out of 85) cases of stillbirths in goats in iodine-deficient areas of Eastern Uttar Pradesh.

Our observations on thyroids and the reports of Lall[4] and Rajkumar[5] indicate the seriousness of goitre to the life of new-born kids which can be avoided by proper supplementation of iodine in diet, especially during pregnancy in goats.

Thanks are due to Dean B. K. Soni, Dr. Ratan Singh, Head of the Department of Medicine and Surgery, for their encouragement and to Dr. S. P. Garg for his interest.

College of Vet. Medicine,
U.P. Agric. University,
Pantnagar, Dist. Nainital,
October 26, 1970.

S. K. GUPTA.
U. K. SHARMA.

1. Blood, D. C. and Henderson, J. A. *Veterinary Medicine*, 2nd Ed., Baillere Tindal and Cox, London, **1963**.
2. Cohrs, P., *Text-Book of Special Pathological Anatomy of Domestic Animals*, Trans. by R. Crawford, First English Edition, Permagon, Oxford, **1967**.
3. Jubb, K. V. F. and Kannedy, P. C., *Pathology of Domestic Animals*, Academic Prees, New York, **1963**.
4. Lall, H. K., *Ind. Vet. J.*, **1952**, **29**, 133.
5. Rajkumar, S. S., *Ibid.*, **1970**, **47**, 185.
6. Wooldrige, W. R., *Farm Animals in Health and Disease*, 2nd Ed., Lockwood, London, **1960**.

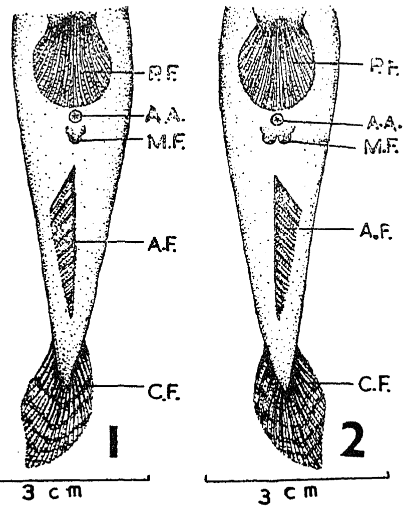
SEXUAL DIMORPHISM IN INDIAN FRESHWATER GOBY, *GLOSSOGOBIUS GIURIS* (HAM.)

SEXUAL dimorphism is a well-marked phenomenon in animals for differentiating the males from females of the same species. Sexual dimorphism is characterised either by the primary sexual characters or the secondary sexual characters. The primary sexual characters include gonads and their related organs and their discernment require dissection of the animal. The secondary sexual characters may or may not be directly relevant to the process of reproduction, but they are very much useful in the identification of the two sexes.

In the present work, the fish *Glossogobius giuris* (Ham.) was collected locally from Saugar

Lake, Sagar (M.P.). The fish ranged from 7·5 cm. to 13 cm. in length.

The observations were made on about 250 specimens. The anal aperture is situated on the ventral side of the fish in the posterior part of the body behind the limits of the pelvic fin. Just behind the anal aperture and anterior to the anal fin there is a muscular flap which is lobe-like in its outline. The latter forms a covering over urino-genital aperture. The structure of this muscular flap enables to differentiate the male specimen from the female. In the male fish, the muscular flap is a small, rudimentary and single-lobed structure, while in the female fish, it is more pronounced and is bi-lobed in outline (Figs. 1 and 2).



FIGS. 1–2. Fig. 1. Ventral view of the male *G. giuris*. Fig. 2. Ventral view of the female *G. giuris*. (A.A., Anal aperture; A.F., Anal fin; C.F., Caudal fin; M.F., Muscular flap over the urino-genital aperture; P.F., Pelvic fin.)

In all these fish possessing single or bi-lobed muscular flap, the sex was confirmed after dissection. The fish *Glossogobius giuris* exhibits sexual dimorphism which has not been reported so far in the available literature.

I am very much thankful to Dr. H. N. Bhargava, Head of Department, for his guidance, and to the C.S.I.R., New Delhi, for a Junior Research Fellowship.

Dept. of Zoology, D. N. SAKSENA.
University of Saugar,
Sagar (M.P.), *October* 26, 1970.

A NEW LABORATORY TECHNIQUE FOR PRESERVATION OF PLANT SPECIMENS

MUCH attention has been paid during the last 30 years or so towards improving the methods of preserving plant specimens in laboratory and museum. The traditional method has been the use of blotters and artificial heat for plant dehydration. Formaline, alcohol and copper-acetate solution are also used successfully to some extent for preservation of plants and their colours. Recently, Chitaley and Chitaley (1966) have used castor oil and artificial heat for dehydration and colour preservation. The present technique is intended not primarily for colour preservation, though it achieves it in many, but mainly for the preservation of plant morphology. Different plant parts like roots, stems, leaves, flowers, and even fruits are better preserved by this new technique.

A viscous solution of *Polystyrene* or *Celloidin-in-flocken* in *Butylacetate* or only *Polystyrene* in *Xylol* is prepared. It is poured on a glass plate and a freshly collected plant part is first pressed a little for 5–10 minutes, and then kept on the glass plate and is again flooded over by the same solution. At room temperature after 10–12 hr., the specimens get dehydrated and sealed-in between the two layers of the dried solution. The ensheathed specimen can then be removed from the glass plate and fixed on white thick paper.

It is observed that the preservation and dehydration is not only good but their colours are also retained well. *Polystyrene-xylol* solution seems to preserve maximum colours. There is no decay and fungal attack. The red flowers of *Hibiscus*, *Mirabilis*, *Rose*, *Canna*, *Ixora*, *Antigonon*, *Bougainvillea*, *Salvia*, *Tropiolum*, *Phlox*, *Bauhinia*, *Callistemon*, *Ipomoea*, *Ceasalpinia*, *Delonix*; the pink of *Gomphrina*, *Astigonon*, *Nerium*, *Bougainvillea*, *Mirabilis*, *Phlox*; the yellow of *Sunflower*, *Merigold*, *Ticoma*, *Momordica*, *Cassia*, *Tropiolum*, *Thevetia*; the blue of *Clitoria*; the violet of *Thunbergia*; the green leaves of *Ipomoea*, *Tamarindus*, *Acacia*, *Rose*, *Coccinia*, *Antigonon*, *Duranta*, *Grass*, *Fern* and *Asparagus*, *Ruscus muchlenbeckia* are very well retained. Fading or change of colours is seen in the red of *Quamoclit*, *Hamelia*, *Russelia*; the blue of *Jacquemontia*, *Ipomoea*, *Rangia*; the pink of *Barleria*; the violet of *Ipomoea*; and the green leaves of *Oxalis*.

I am highly grateful to the Director and Head of the Department of Botany for providing facilities. Thanks are also due to Mr. M. K. Mahajan and A. Qurashi for their help and suggestions.

Bot. Lab. Inst. of Science,
Nagpur, *October* 23, 1970.
M. T. SHEIKH.

---

1. Chitaley, S. D. and Chitaley, D. V., *Investigation Intelligence*, 1966, **2**, 5.

SALT TOLERANCE IN METHI AT GERMINATION STAGE

METHI (*Trigonella foenum-graecum* L.) is an important vegetable crop and is valued for its leafy portion and eaten either raw or cooked. This note reports the results of a study of the salt tolerance in methi under laboratory conditions at germination stage.

TABLE I

Germination percentage in methi as influenced by salt levels

Salt concentrations molars	Hours after sowing							Germination percentage
	24	48	72	96	120	144	168	
Control ..	21·2	59·6	7·0	7·0	0·5	1·0	0·0	96·45
0·02 ..	2·0	58·3	16·0	16·0	2·0	2·0	0·0	96·45
0·04 ..	0·55	42·9	26·7	7·6	6·0	1·0	0·5	85·45
0·06 ..	0·0	24·2	15·6	19·6	6·7	3·0	0·0	69·30

F test significant : C.D. at 5% =15·8

C	T_1	T_2	T_3
96·45	96·45	85·4	**69·3**

Blotting-papers dipped in 0·02% ceresan, to avoid fungus growth, were kept inside petri-dishes. Hundred healthy seeds of local methi variety were used for each treatment and there were two replications. The seeds were pre-treated with 0·002% ceresan solution. Sodium chloride solutions of 0, 0·02, 0·04 and 0·06 molar were prepared in distilled water and were applied to the respective treatments. Data on germination were recorded at intervals of 24 hours and were statistically analysed. The results are shown in Table I.

From Table I it is seen that control and 0·02 molar concentration gave equal germination percentage after 168 hours though there was delay by 24 hours in the case of 0·02 molar. Initial effect of salt is compensated by an improvement in germination after 72, 96, 120 and 144 hours. In the other two cases, there is reduction and delay in germination percentage as the salt concentration increases. Thus methi can tolerate salt concentration up to a level of 0·04 molar but there is reduced germination percentage which is statistically insignificant. Hence, the delay and fall in germination has been attributed to the osmotic concentration of the media and ionic effect of salts in the substrate. These findings are in agreement with those of several other workers.[1-4]

Univ. of Agric. Sciences,
Dharwar Campus,
October 23, 1970.
A. F. HABIB.
T. SWAMY RAO.
S. W. MENSINKAI.

---

1. Kaliappan, R. and Rajgopal, A. *Madras Agri. J.*, 1970. **57** (4), 231.
2. Patel, A. S. and Dastane, N. G., *Indian J. Agron.*, 1968, **13** (4), 280.
3. Richards, L. A., *Agri. Handbook USDA No. 60*, 1954.
4. Seshgiri Rao, T., Achar, H. P. and Hadimani, A. S., *J. Indian Soc. Soil Sci.*, 1969, **17** (4), 431.

NOTE ON A STRAIN OF *NOSTOC LINCKIA* UNABLE TO USE MOLECULAR NITROGEN

ANTIBIOTIC resistance in micro-organisms is well known, which may arise as spontaneous mutations, the drugs acting as a selective factor or as a drug-directed variation,[1-3,8-10] although both are not mutually exclusive. During the course of studies on antibiotic resistance in blue-green algae, a variant of a nitrogen-fixing strain of *Nostoc linckia* ARM 53 was obtained using streptomycin, which was unable to assimilate molecular nitrogen. The present report deals with this strain.

The parent material (W) was cultivated in a nitrogen-free inorganic medium containing per litre : 0·25 g. $MgSO_4.7H_2O$, 0·23 g. NaCl, 0·06 g. $CaCl_2.6H_2O$, 0·36 g. K_2HPO_4, 1 ml. Fe-EDTA and 1 ml. A_5 micronutrient solution (pH 7·5). The filaments were short during the first few days of growth in turbulent cultures. The material was washed with saline and inoculated into fresh medium containing penicillin or streptomycin (0–50 µg./ml.) at an initial concentration of 25×10^4 filaments per ml. The cultures were incubated on a rotary shaker at 32 ± 1° C. for 12 days under continuous illumination (5,000 lux).

The growth of the alga was found to be inhibited with the increasing concentrations of the antibiotics. While step-wise increase in the resistance to penicillin was found possible upto 1,000 µg./ml., the alga failed to grow at concentrations of streptomycin above 0·2 µg./ml. At 0·2 µg. streptomycin/ml., the growth was abnormally slow. The material from this concentration level was washed with saline and transferred to drug media with and without ammonium sulphate (0·25 g./l). While the alga grew well in the series containing nitrogen, it failed to grow in the nitrogen-free medium. Strain S^rN^+ was isolated from this culture which could not fix nitrogen, as evidenced by its failure to grow in nitrogen-free medium and its inability to bring about an increase in the fixed nitrogen as measured by the kjeldahl method (Table I).

TABLE I

Specific growth rates of penicillin (P^rN^-) and streptomycin ($S^r N^+$) resistant strains of Nostoc linckia

Strains		k
Wild	..	0·11
P^rN^- (1,000 µg. penicillin/ml.; N-free)	..	0·04
S^rN^+ (0·02 µg. streptomycin/ml.; N-free)	..	0
S^rN^+ (0·02 µg. streptomycin/ml.; with N)	..	0·066

Repeated transfers in media with and without the drugs and nitrogen source were carried out to determine the stability of the strains with respect to their resistance to the drugs and the inability to assimilate molecular nitrogen.

The strains isolated were of the following types:

(a) P^rN^-, resistant to 1,000 µg. penicillin/ml. and could grow in nitrogen-free medium (Fig. 1), and

(b) S^rN^+, resistant to 0·2 µg. streptomycin/ml., but unable to use molecular nitrogen (Fig. 1). Nitrogen fixation by this strain could not be stimulated by the addition of a variety of substances like vitamins, bases and casein hydrolysate. But it grew well when exogenous ammoniacal nitrogen was provided. The block appears to be between N_2 and NH_3.

Figure 1 shows the growth of P^rN^- and S^rN^+ strains in their respective antibiotic containing media, after several transfers in drug-free media.

Drug resistance in these two strains has also been found to be accompanied by a fourfold increase in their resistance to ultra-violet irradiation (2537 Å; distance 16") (Fig. 2). The LD_{50} dose of UV-irradiation for the wild strain was about 1·2 min., while for the P^rN^-

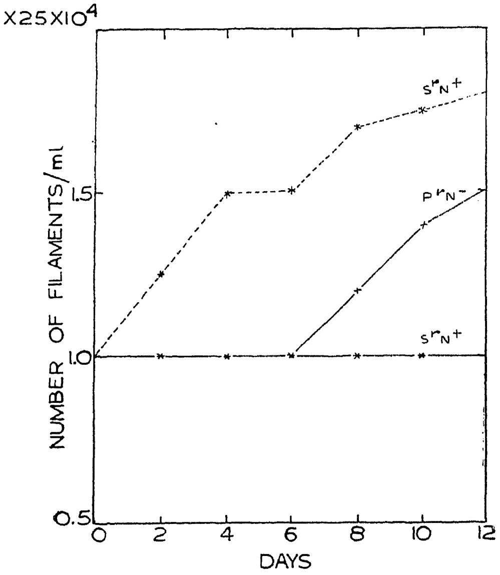


FIG. 1. Growth curves of P^rN^- and S^rN^+ strains of *Nostoc linckia* (- - - - - nitrogen supplemented medium; ——— nitrogen-free medium).

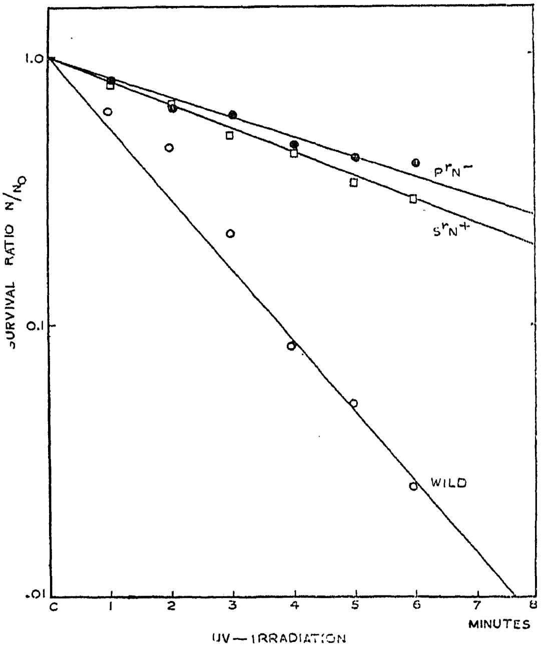


FIG. 2. UV survival curves of W, P^rN^- and S^rN^+ strains of *Nostoc linckia*.

and S^rN^+ strains, it was about 4 min. Drug-resistant strains are known among blue-green algae.[6,7,9] Of particular interest is the loss of nitrogen-fixing capacity in the streptomycin-resistant S^rN^+ strain, which proved to be radio-resistant also. The use of variants with such biochemical markers in studies on the mechanism of nitrogen fixation has been shown in the case of *Azotobacter*.[4,5] The relationship between drug resistance and the loss of a biochemical activity needs further examination.

Dept. of Microbiol., H. AHMAD.
I.A.R.I., New Delhi-12, G. S. VENKATARAMAN.
October 12, 1970.

1. Bryson, V. and Demerec, M., *Ann. N.Y. acad. Sci.*, 1950, **53**, 283.
2. Demerec, M., *J. bacteriol.*, 1948, **56**, 63.
3. Eagle, H., Fleischman, R. and Levy, M., *Ibid.*, 1952, **63**, 623.
4. Fischer, A. G. and Winston, J. B., *Biochem. biophys. Acta*, 1959, **184**, 99.
5. Green, M., Alexander, M. and Wilson, P. W., *J. bacteriol.*, 1953, **66**, 623.
6. Kumar, H. K., *J. exptl. bot.*, 1964, **15**, 232.
7. —, *Plant & Cell Physiol.*, 1964, **5**, 465.
8. Lederberg, J. and Lederberg, E. M., *J. bacteriol.*, 1952, **63**, 399.
9. Luria, S. E. and Delbrück, M., *Genetics*, 1943, **28**, 491.
10. Singh, R. N., Singh, H. N. and Sinha, R., *Indian J. Genetics*, 1966, **26A**, 405.

ROOT-KNOT NEMATODES AND BACTERIAL NODULATION IN SOYBEAN

THE interrelationships between nitrogen-fixing bacteria (*Rhizobium* spp.), plant-parasitic nematodes and their leguminous hosts have not been adequately studied. The possible role of nematodes in modifying the nodulation of legume roots needs to be understood. Hence, a study was undertaken to determine whether three species of root-knot nematodes, *viz.*, *Meloidogyne incognita* (Kofoid and White, 1919; Chitwood, 1949), *M. javanica* (Treub, 1885) Chitwood, 1949, and *M. hapla*, Chitwood, 1949, could cause reduction of bacterial nodulation in soybean and to find out the effect of different inoculum levels of *M. javanica* on the nodulation, indexed 35 days after inoculation.

The contents of 7 ounce bag of Legume Aid *R. japonicum* (Kirchner, 1895), Buchanan, 1926, were thoroughly mixed with the soil to fill 4-inch pots. Five seeds of soybean variety Adams were sown. Pure cultures of *Meloidogyne* spp. started from single egg mass were obtained from the green house where they were maintained in tomato plants. The egg masses of *M. incognita, M. hapla, M. javanica* were teased out from the roots of tomato plants and the second stage larvae were obtained, following the method of Dropkin *et al.*[1] One thousand larvae were inoculated per pot, ten days after germination. Five replications were maintained in each case. Five pots without nematodes served as control. Thirty-five days after inoculation, the plants were removed, the root system washed free of soil and indexed to the degree of nodulation from 0 to 5 (0—no nodulation; 5—heavy nodulation). The root-knot index was based according to Smith and Taylor.[2] To determine the inoculum levels of *M. javanica*, 0, 10, 100, 1,000 second-stage larvae were inoculated on soybean plants in pots with *R. japonicum* containing soil, as described earlier and root-knot and nodulation were indexed.

All the three species of root-knot nematodes used in this study (*M. javanica, M. hapla* and *M. incognita*) caused reduction in bacterial nodulation (Table I). The root nodule index varied from 0·1 to 3·8. The plants inoculated with *M. javanica* suffered a severe reduction of root nodulation and showed a higher root-knot index. The nodules of the control plants were bigger and softer than in nematode infected plants where the nodules were smaller and harder. In general, root-hair production was less in the plants inoculated with the nematodes. Reduction of bacterial nodulation was marked in the plants inoculated with 100 and 1,000 larvae. There was no difference in nodulation indices between the plants which received 100 or 1,000 larvae per plant even though there were differences in root-knot

TABLE I

The effect of 1,000 *larvae of* Meloidogyne javanica, M. hapla and M. incognita *on soybean bacterial nodulation*

Treatment		Nodule index*	Root-knot index†
M. javanica	..	0·1	3·7
M. hapla	..	1·2	3·3
M. incognita	..	2·0	3·0
Control (no nematodes)	..	3·8	0·0

* Mean of 25 plants; index based on 0—no nodules; 5—heavy nodulation (indexed 35 days after inoculation), † After Smith and Taylor, 1947.
0—No roots galled
1— 1- 25% roots galled
2—26- 50% ,,
3—51- 75% ,,
4—76-100% ,,

indices (Table II). There was no reduction of bacterial nodulation at the inoculum level of 10 larvae.

TABLE II

The effect of 0, 10, 100, 1,000 larvae of Meloidogyne javanica *on soybean bacterial nodulation*

Treatment		Nodule index*	Root-knot index†
Control	..	3·7	0
M. javanica 10 larvae	..	3·2	1·4
,, 100 ,,	..	0·3	3·0
,, 1,000 ,	..	0·2	3·4

*, † Same as in Table I.

The results indicate that *M. javanica, M. incognita* and *M. hapla* could cause reduction of bacterial nodulation in soybean. Previously, reduction of bacterial nodulation by *M. incognita acrita* Chitwood, 1949, on soybean, *M. javanica* on cowpea, *Trichodorus christiei* Allen, 1957, and *Criconemoides curvatum* Raski, 1952, on hairy vetch have been reported.[3-5] Further, the inoculum level of *M. javanica* as low as 100 larvae caused reduction of the nodulation. The reduction of nodulation might be due to root-knot larvae interfering directly with the establishment of nitrogen-fixing bacteria as indicated by the lesser production of root hairs in the infected plants, thereby destroying the root-hair infection by *Rhizobium* spp. Reduced numbers of nodules might also be due to overall reduction of root system, as indicated by Taha and Raski,[6] on white clover by *M. javanica* and *Heterodera trifolii* Goffart, 1932. It is also possible that nematodes render the infected plant roots physiologically incompatible to the bacteria. This area requires further research.

The author wishes to thank Dr. W. R. Jenkins, Professor of Nematology, Rutgers, The State University, New Brunswick, N.J. (U.S.A.), for his guidance in carrying out this work.

Faculty of Agric., M. BALASUBRAMANIAN.
Annamalai University,
Annamalainagar, *October* 20, 1970.

1. Dropkin, V. H., Martin, G. C. and Johnson, R. W., *Nematologica*, 1958, **3**, 115.
2. Smith, A. L. and Taylor, A. L., *Phytopathology*, 1947, **37**, 85
3. Shards W. A. and Crittenden, H. W, *Ibid.*, 1957, **47**, 454.
4. Robinson, P. E., *Nature*, 1961, **189**, 506.
5. Malek, R. B. and Jenkins. W. R., *N.J. Agric. Expt. Sta. Bull No. 813*, 1964, p. 32.
6. Taha, A. H. Y. and Raski, D. J., *J. Nematology*, 1969, **1**, 201.

OBSERVATIONS ON THE GLYCO-ALKALOID CONTENT OF DIPLOID AND TETRAPLOID *SOLANUM KHASIANUM* CLARKE

Solanum khasianum has attracted the attention of modern pharmacologists because of its high solasodine content.

Solasodine is a nitrogen analogue of diosgenin which is a precursor for various steroid hormones and hence can replace the latter, resources of which are limited.

Saini *et al.*[1] studied the growth of *S. khasianum* under cultivation and found that its glyco-alkaloid content varied from 1·9% to 7·6% of dry weight, depending on the maturity of fruits, pale yellow fruits having the maximum amount.

Tetraploidy was successfully induced in *S. khasianum* by colchicine (E. K. Janaki Ammal and B. Bhatt—in press). The glyco-alkaloid content of six diploids and four tetraploids as percentages of dry weight is shown in Table I. The moisture content of the fruits at the time of analysis was about 78%.

TABLE I

Estimation of glyco-alkaloid in diploid and tetraploid S. khasianum

Plant No.	Av. weight of fruits gm.	Glyco-alkaloid % of dry weight
Diploids		
IX 3	4·3	4·3
IX 7	4·5	4·8
IX 2	5·0	4·2
IX 5	7·0	3·3
IX-4	8·7	2·8
Tetraploids		
V-3	2·8	7·4
V 6	3·2	2·6
XII 6	3·2	1·4
II-6	3·6	7·6

The glyco-alkaloid content of the control diploids ranged from 2·8% to 4·8% showing that variability existed in the controls. This variability was also noticed in the tetraploids. An interesting feature brought out from these studies is that the larger fruits in the control had less glyco-alkaloid than the small ones. However, two out of four tetraploids analysed showed 7·4% and 7·6% glyco-alkaloid conten which is higher than the maximum 4·8% found in the diploids. The difference in size of the diploid (upper) and tetraploid (lower) is shown in Fig. 1.

Saini[2,3] is of the opinion that the glyco-alkaloid of *S. khasianum* is concentrated in a mucilage layer around the seeds, and hence directly correlated with the number of seeds in each fruit. Thus poor seed setting would be expected to result in proportionately reduced alkaloid content. Our experience is exactly the opposite. Although diploid fruits had 200–300 seeds, their glyco-alkaloid content was found to be less than that in some tetraploids which contained only 2–5 seeds.

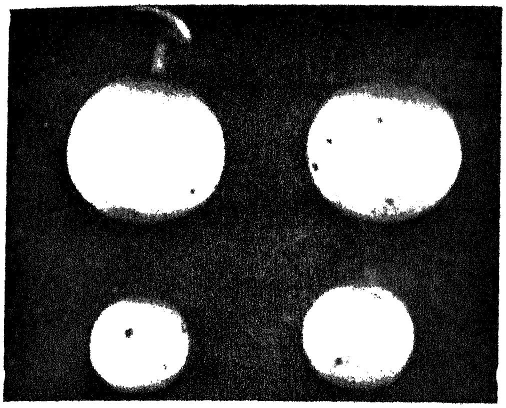


FIG. 1. [illegible] Top, Diploid; Bottom, Tetraploid.

These preliminary findings indicate that sterility and smaller fruits which are considered a disadvantage in induced tetraploidy might prove to be of advantage in the case of *Solanum khasianum*.

Biology Division,
Bhabha Atomic
Research Centre,
Trombay, Bombay-85,
November 9, 1970.

E. K. JANAKI AMMAL*
BHARATI BHATT

---

* Centre for Advanced Studies in Botany, University of Madras, Madras-5.

1. Saini, A. D., Mukherjee, M. and Biswas, R. C., *Ind. Jour. Plant Physiol.*, 1965, 8, 103.
2. ——, *Curr. Sci.*, 1966, 35, 600.
3. —— and Biswas, R. C., *Ind. Jour. Plant Physiol.*, 1957, 10, 1.

REVIEWS AND NOTICES OF BOOKS

An Introduction to Metabolic Pathways. By S. Dagley and Donald E. Nicholson. (Blackwell Scientific Publications, 5, Alfred Street, Oxford OX1 4HB, England), 1970. Pp. 343. [illegible]

Dr. Nicholson's Metabolic Pathways Chart is well known and is referred to and used in biological laboratories throughout the world. To meet the growing demand for the chart and for information on associated literature, the authors have decided to present in book form separate charts of pathways in which enzymes are named and references are cited.

The first few chapters of the book are concerned with the ideas and methods involved in the determination of metabolic pathways, and the ways in which they are controlled ultimately on the genetic level. Then in about 150 pages of charts are given some of the more important pathways of metabolism. These pathways are arranged in a logical sequence with relevant enzymes, co-factors and references inserted between each reaction. A great amount of thought has been given to the presentation and design of the pathways cited in the book. References are given in about 70 pages at the end. An author index and a subject index of great utility to the users are also included.

The publication will find ready welcome by researchers and students working in this growing field of biological science.

A. S. G.

An Introduction to Ion Exchange. By Russell Paterson. (Published by Heyden & Son Ltd., Spectrum House, Alderton Crescent, London NW 4), Pp. 109. Price £ 2.10.0; $ 6.00; DM 22.50.

The development of synthetic ion exchange resins some three decades ago laid the foundations for a new industry and a new unit operation which have grown remarkably since then. New and improved ion exchangers continue to be developed. This rapid growth in both theory and applications necessitates an up-to-date introductory text for those familiar with basic principles of physical chemistry and who wish to know something in this field. This book fulfils this purpose. It provides a comprehensive and sound introduction to all aspects of the ion exchange process, including a description of all currently available types of ion exchange materials.

A. S. G.

Rothamsted Experimental Station—Report for 1969. In Two Parts. (Obtainable from the Librarian, Rothamsted Experimental Station, Harpenden, Herts, England), 1970. Price £1-10-0.

As initiated last year, this year's Report of the Rothamsted Experimental Station is also in two parts. Part I of 464 pages, describes in detail the progress and results of the work of the year (1969) in the 13 departments of the Station, the field and the farm experiments, and notes on the Soil Survey of England and Wales. It also gives the Abstracts of some 300 papers published during the year from the various departments.

Part II of 192 pages contains papers by members of the Rothamsted staff. These concern amongst others: (1) The value of residues from long-period manuring at Rothamsted and Woburn, (2) Rhizobium in the soils of Rothamsted and Woburn Farms, (3) Rothamsted Insect Survey, and (4) Chemical Control of Plant Growth. A. S. G.

Silicoflagellates and Ebridians. By A. R. Loeblich, III, L. A. Loeblich, H. Tappan and A. R. Loeblich Jr. (The Geological Society of America, P.O. Box 1719, Boulder, Colorado 80302), 1968. Pp. 319. Price $ 12.50.

The silicoflagellates and ebridians are minute silica-secreting marine planktonic flagellates. They have been known both in the fossil state and from the present seas for more than a century. The importance of these organisms in stratigraphy has been well recognized and it is to focus attention on this aspect of their study that this Memoir has been prepared.

It indexes all published silicoflagellate and ebridian taxa of generic rank and lower, both fossil and Recent. This Memoir will serve as a single reference source for original descriptions and illustrations of all validly proposed taxa through 1967. A. S. G.

Aspects of Fish Parasitology. Edited by Angela E. R. Taylor and R. Muller. (Blackwell Scientific Publications, 5, Alfred Street, Oxford, OX 1, 4 HB, England), 1970. Pp. 167. Price 60 *sh.*

This volume contains the papers presented at the eighth symposium of the British Society of Parasitology, held at the Zoological Society of London on November 7th 1969. The titles and the authors of the papers are as follows: (1) Ecological Studies of Some Parasites of Plaice, *Pleuronectes platessa* (L.) and Flounder, *Platichthys flesus* (L.), by M. MacKenzie and D. Gibson; (2) The Alimentary Canal of Fish as an Environment for Helminth Parasites, by H. H. Williams, A. Mc Vicar and R. Ralph; (3) The Physiology of Fish Parasites, by C. Arme and M. Walkey; (4) Biological Aspects of the Parasitism of Freshwater Fishes by Crustaceans and Molluscs, by G. Fryer; (5) The Parasite Fauna of British Freshwater Fish, by J. C. Chubb; and (6) The Population Biology of Helminths of British Freshwater Fish, by C. R. Kennedy.

The papers are chiefly concerned with the parasites of British fish but they will be of interest to all helminthologists.

A. S. G.

Advances in Cryogenic Engineering, Vol. 15. Editor: K. D. Timmerhaus. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. 484. Price $ 27.50.

It will be recalled that the first volume of *Advances in Cryogenic Engineering* appeared in 1960. With successive issues of the journal it is becoming increasingly recognized that this journal acts as a continuing guide-book providing knowledge on the latest developments in low-temperature engineering.

The present volume contains the Proceedings of the 1969 Cryogenic Engineering Conference held at The University of California, Los Angeles, in June 16–18, 1969. The contents include invited papers and discussions also. Fifty-five papers presented at the Conference are arranged under the following heads: Liquefied Natural Gas Technology; Thermodynamic Properties; Fluid and Solid Properties; Mechanical Properties; Superconductivity; Superconducting Magnets; Heat-Transfer; Insulation; Fluid Dynamics; Gas Purification Systems; Refrigeration Systems; and Cryogenic Systems. A. S. G.

Molecules and Life—An Introduction to Molecular Biology. By M. V. Vol'kenshtein. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011, U.S.A.), 1970. Pp. 513. Price $ 15.00.

This is an English translation of the original Russian text published in 1965, and which has been extensively revised and updated by the author for this edition.

By now it is well known that biological processes taking place at molecular level are essentially of the same type in all biological systems, from bacteria to man. The working substances of these elemental biological processes at the molecular level are proteins and nucleic acids. The phenomenon of life is concerned with the organization and structural complementarities of these biomolecules.

The book under review provides a comprehensive introduction to molecular biophysics. It deals principally wtih the structures and functions of proteins and nucleic acids. The text includes chapters on biological molecules, physics of macromolecules, the physics of proteins and nucleic acids, protein synthesis, biological specificity and structure of molecules, mechanochemical processes, and molecular biophysics and quantum mechanics.

The book contains descriptive sections as well as sections devoted to rigorous mathematical treatment of concerned problems. It will serve as a suitable text-book on molecular biology for advanced students and to research workers taking to this field of investigation.

A. S. G.

ANNOUNCEMENTS

Lady Tata Memorial Trust

Scholarships of Rs. 500 each per month and of Rs. 300 each per month, tenable for one year in the first instance, in India only, are offered to Indian Nationals. The Rs. 500 awards are open to post-graduate or graduate applicants with degree in Medicine, of a recognised University. Rs. 300 awards are open also to those who hold a Master's degree in Science or who have graduated with distinction from a recognised University. The subject of investigation must have a bearing on the alleviation of human suffering from disease.

The last date for receiving the applications is 31st March 1971.

For further particulars apply immediately to the General Secretary, Lady Tata Memorial Trust, Bombay House, 24, Bruce Street, Fort, Bombay 1-BR.

Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Geology to Shri Y. J. Pardhasaradhi.

M.S. University of Baroda has awarded the Ph.D. degree in Biochemistry to Shri K. V. Thrivikraman; Ph.D. degree in Geology to Shri Bhagirathkumar Balalshanker Jambusaria.

Osmania University, Hyderabad, has awarded the Ph.D. degree in Physics to Kumari Shanthalakshmi, A. and Kumari Leela Iyengar.

Sri Venkateswara University, Tirupati, has awarded the Ph.D. degree in Zoology to Shri N. Bojji Reddy.

Books Received

Ultrastructure of Bacterial Viruses. By A. S. Tikhonenko. (Plenum Publishing Corporation, New York 10011), 1970. Pp. x + 294. Price $ 19.50.

Biochemistry of Antibodies. By R. S. Nezlin. (Plenum Publishing Corporation, New York 10011), 1970. Pp. xiii + 381. Price $ 25.00.

General Chemistry. By A. L. Williams, H. D. Embree and H. J. Debbey. (Addison-Wesley Publishing Co., Inc., London W. 1, England), 1970. Pp. xii + 369. Price 84 *sh.*

A First Course in Rings and Ideals. By D. M. Burton. (Addison-Wesley Publishing Co., Inc., London W. 1, England), 1970. Pp. viii + 309. Price 98 *sh.*

Annual Review of Biochemistry, Vol. 39. (Annual Reviews, Inc., 4139, El Caminoway, Palo Alto, California), 1970. Pp. vii + 1136. Price U.S.A. $ 13.00; Foreign $ 13.50.

Atmospheric Optics. Edited by Nikolai B. Divari. (Plenum Publishing Corporation, New York 10011), 1970. Pp. vi + 178. Price $ 27.50.

Physics Without Einstein. By Harold Aspden. (Sabberton Publications, P.O. Box 35, Southampton, England), 1969. Pp. x + 224. Price not given.

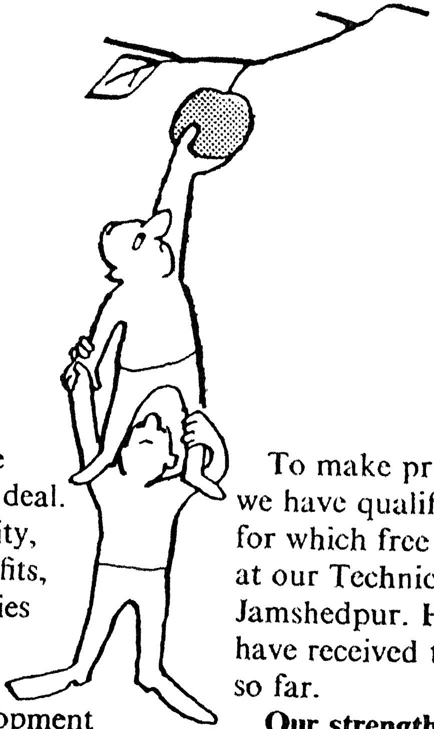
The Development and Organization of Scientific Knowledge. By Harold Himsworth. (William Heinemann Ltd., London), 1969. Pp. viii + 180. Price 63 *sh.*

Fields and Waves in Communication Electronics. By S. Ramo, J. R. Whinnery and T. V. Duzer. (Wiley Eastern Private Ltd., J-41, South Extension, New Delhi-49), 1970. Pp. xvi + 754. Price Rs. 22·50.

Free Nitroxyl Radicals. By E. G. Rozantse. (Translated from Russian by B. J. Hazzard; Edited by H. Ulrich.) (Plenum Publishing Corporation, 227, West 17th Street, New York, N.Y. 10011), 1970. Pp. xiv + 249. Price $ 19.50.

2519-71. **Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, L.P.T., Superintendent, at The Bangalore Press, Bangalore-18.**

We help our workers to help themselves.



We think our workers are entitled to more than a fair deal. So, in addition to job security, they enjoy many other benefits, a number of welfare amenities

But this is not all.

We also recognise the workers' need for self-development by offering higher job opportunities.

To make promotions impartial, we have qualifying trade tests, for which free training is offered at our Technical Institute at Jamshedpur. Here, 10,000 have received technical training so far.

Our strength is in our people as much as in our steel.

TN.2015

TATA STEEL

ORGANIC MATERIALS IN THE MARINE ENVIRONMENT AND THE ASSOCIATED METALLIC ELEMENTS*

T. N. V. PILLAI, M. V. M. DESAI, ELIZABETH MATHEW, S. GANAPATHY AND
A. K. GANGULY

Bhabha Atomic Research Centre, Health Physics Division, Bombay-85

ABSTRACT

Dissolved organic matter obtained from an algal culture grown in marine medium solubilizes trace elements. The rate at which the solubilized elements change their ionic properties with the growth of the culture and the relative abundance of cationic, anionic and non-ionic species (at different periods of culture growth) of these elements were studied at elemental concentration upto 500 μg/1. The probable role of PO_4 and of the organic constituents in the solubilization or fixation of trace elements on the organic matrices has been indicated.

Influence of organic constituents on the sorption of trace elements by marine sediments has been investigated for some elements such as Zn, Mn and Co. The sorption of Zn, Mn and Co by a sample of coastal marine sediment was observed to be many times higher than by the same sediment freed of organic matter by H_2O_2 treatment whereas sorption of alkali and alkaline earth elements such as Cs, K, Ca and Sr did not show any significant difference.

Complete hydrolysis of the humic and fulvic acids extracted from marine sediments could not be established and as such amino-acids, purines, pyrimidines and carbohydrates were qualitatively identified. Trace element analyses showed that the humus materials were high in the content of trivalent elements such as Al and Fe and of bivalent elements such as Cu and Zn. Of the associated metallic elements Ca and Mg are found to be mostly exchangeable cationic in their behaviour on Dowex-50 column, major fractions of Al, Fe, Cu and Zn escape through the cation column—indicating different states of combination of the metallic elements with the humus complex.

Studies on the interaction of humic acid with added solutions of trace elements show that alkali and alkaline earth elements such as Sr, Ba, Ra exist in exchangeable cationic, transition elements such as Zn, Mn, Cu and Co exist in cationic and non-cationic, while trivalent and heavy elements exist mostly in non-cationic forms in the humic acid. Similar were the observations with fulvic acid. The ionic behaviour of humic and fulvic acid complexes of the elements are compared and their characteristics are discussed.

INTRODUCTION

MODEL of distribution of trace elements, existing entirely as inorganic species in the marine environment, needs revision in view of new data being accumulated on the influence of organic constituents on the physico-chemical state of trace elements. Most of the global organic matter is present in the ocean in dissolved form and in the sediments as humus material (*cf.* Table I). The final resting place for organic materials in sea-water is in the sediment as humus substances—complex of organic monomers of high biochemical stability.[2]

TABLE I[1]

Carbon content of natural exchange reservoir

Carbon reservoir		Carbon content (g /cm^2 of earth's surface)
Atmosphere	..	0·125
Humus	..	0·19
Biosphere (land)	..	0·06
Biosphere (marine)	..	0·002
Oceanic dissolved carbon (organic)	..	0·533
Oceanic inorganic carbon (above thermocline)		0·20
Oceanic inorganic carbon (below thermocline)		7·25

Sea-water is known to contain in dissolved state,† a number of organic (ligands) compounds such as amino-acids, peptides, carbohydrates, etc.[3] Hydrolytic products of the humus material have also been found to contain carbohydrates, amino-acids, etc.[4,5] The complexing properties of these leading to solubilization/fixation of a host of trace elements in organic compounds or matrices is a complicated process, progressive elucidation of which will lead to better understanding of the distribution of these metallic species in oceanic waters.

---

* Adapted from the paper presented at the IAEA Symposium on Distribution of Chemical Species in Marine Environment held in Tokyo in September. 1970

† Material passing through 0·45 μ membrane filter is usually considered as 'dissolved'. We have used in the present work 0·22 μ membrane instead, for filtration.

Solubilization and complexation of elements, such as Ba, Zn, Mn, Fe and Zr-Nb in sea-water culture filtrate containing higher amount of dissolved organic constituents than in natural sea-water, was reported recently by Desai *et al.*[6] and Koshy *et al.*[7] The concentrations obtained for a number of trace elements in natural sea-water exceed the amount one can predict from basic principles of solubility product and inorganic compound—metal ion interactions.[8,10] Solubilization of trace elements in sea-water has been observed by many investigators.[4-9] Presence of dissolved organo-metallic complexes in sea-water was postulated from experimental evidences for Fe, Cu, Zn, Mn and V by earlier workers[11-17] but *in situ* formation and progressive evolution of the chemical state of the metallic elements in the complexes is not dealt with at length in the literature.

The sorption of radioelements by sediments in the sea-water system is, in general, guided by the basic physico-chemical interactions with the sediment such as adsorption, isomorphous replacement and double decomposition. A parameter that has not been well investigated is the role played by organic matter present in the sediment in its sorptive properties.[18]

The organic matter in the sediments is principally composed of the humus material. Soil[20-22] and marine[4,19] humus substances are known to form complexes with a large number of metal ions and these materials in the sediments can thus influence the distribution of such elements in the marine environment. Koshy *et al.*[19] studied the sorption of Cs, Zn, Mn, Co, Cu and Y by a marine humic acid in sea-water medium. Koshy *et al.*[4,19] and Desai *et al.*[5,23] demonstrated the capacity of the humic acid to form soluble and insoluble complexes of elements such as Mn, Zn, Co, Fe, Y, La, Ac and Zr-Nb in sea-water and in ammoniacal medium.

There is a lack of information about the interaction of heavy elements with humus substances (humic and fulvic acids).

COMPLEXATION OF TRACE ELEMENTS BY DISSOLVED ORGANICS

In order to study the formation of metal-organic complexes in dissolved forms in sea-water, cultures of a phytoplankton (*Microcystis littoralis*) were grown in sea-water medium in presence of organic matter free (by H_2O_2 treatment) sediment separately for some radioactive elements containing the inactive carriers of these elements (upto 500 µg. of each per litre). The ionic nature of the elements in dissolved form was determined after 3 days and onwards after the addition of the nutrients containing $^{14}CO_3$ and raising the culture. The supernatants were filtered at intervals of time and an aliquot of each of the filtrates was counted for gamma activity. Two similar aliquots of each were passed through a cation (Na^+) and an anion (Cl^-) column (5 cm. × 1 cm. at the rate of 0·2 ml./min.) and the effluents and washings were counted as before. The detailed experimental procedure is given elsewhere.[5] Results are given in Tables II, III and IV.

Results indicate that amphoteric Zn with time changes from the cationic form of 100% to about 35%, while anionic form completely disappears in course of time—thus indicating the formation of about 65% non-ionic species of Zn organic complex in 16 weeks. Similar behaviour is observed with Mn which is transformed from cationic (100%) form to non-ionic form (70%) in 16 weeks. Co cationic initially changes over to 71% non-ionic form in about 4 weeks and remains so thereafter. Behaviour of Ru is somewhat erratic, but indications are,

TABLE II

Ionic states of Zn, Mn and Fe in presence of dissolved organic constituents at different time intervals

	Dissolved form (%)									
	3 days			21 days			42 days		112 days	
	Zn	Mn	Fe	Zn	Mn	Fe	Zn	Mn	Zn	Mn
Cationic ..	100	100	100	100	93·6	75·5	82·7	88·2	35	28·9
Non cationic* ..	0	0	0	0	6·4	24·5	17·3	11·8	65	71·1
Anionic ..	79	0	15·5	6·4	7·5	50·0	..	..	0	0
Non-anionic† ..	21	100	84·5	93·6	92·5	50·0	..	..	100	100

The elements were added in the chloride form. * Per cent of activity passing through the cation column. † Per cent of activity passing through the anion column.

TABLE III

Ionic states of [illegible] in presence of dissolved organic constituents at different time intervals

	Dissolved form (%)			
	3 days	16 days	28 days	85 days
Cationic	100	36	28·3	28·4
Non cationic	0	64	71·7	71·6
Anionic	0	0	0	0
Non anionic	100	100	100	100

* Added in the [illegible] form.

TABLE IV

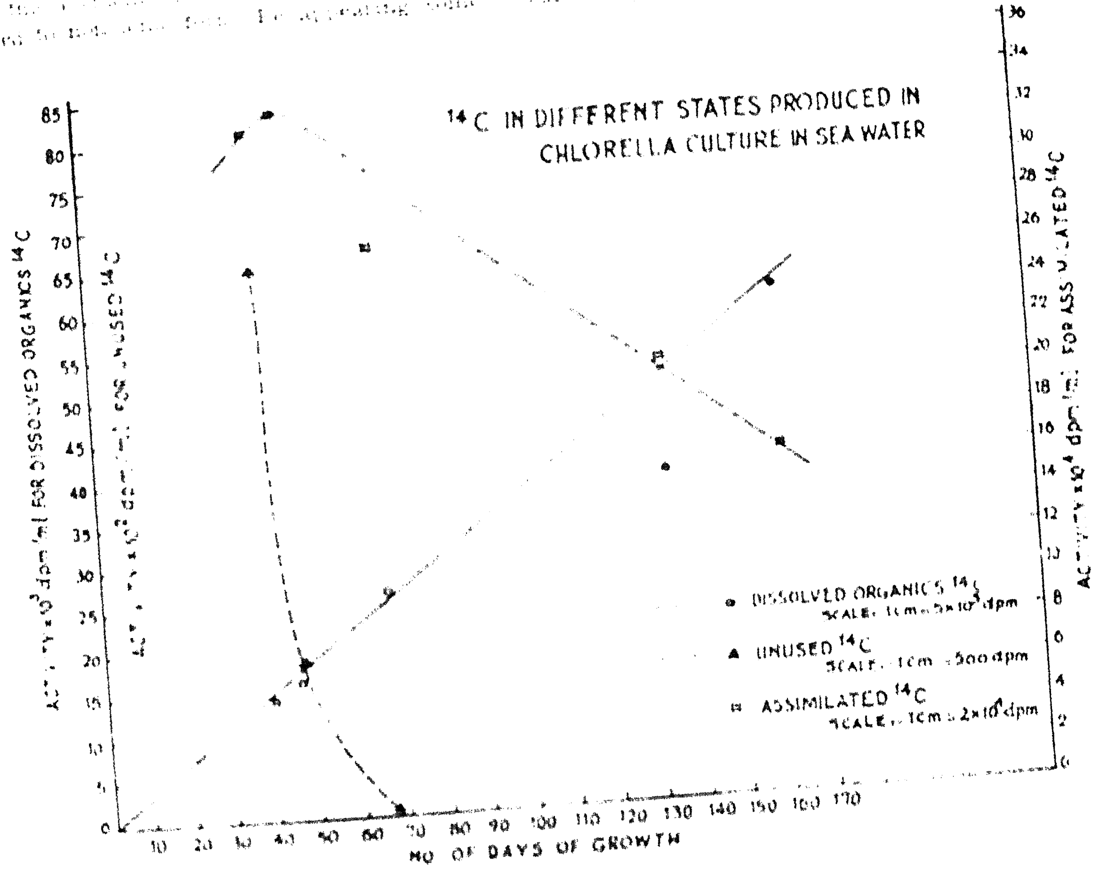
Ionic states of Ru[illegible] in presence of dissolved organic constituents at different time intervals

	Dissolved form (%)			
	7 days	42 days	98 days	112 days
Cationic	32·8	52·6	31	2·5
Non-cationic	67·2	47·4	69	97·5
Anionic	37·9	..	59	0
Non-anionic	62·1	..	41	100

* Added in the [illegible] form.

[illegible] that the [illegible] formed [illegible] form [illegible] appearing somewhat amphoteric after 3 days; develops into at least 25% non-ionic form after 3 weeks.

Build-up of dissolved organic constituents with time in the culture medium was studied earlier by Koshy *et al.*[4] (cf Fig. 1). The nature of the organic constituents building up with time was not investigated. The column behaviour of dissolved organic matter also changed with time as observed by ¹⁴C counting of the influent and effluent in column studies. However, the correlation of the amount of associated organic matter or the nature of the organic compounds involved in different complex formation could not be followed. As will be evident in sequel that several metallic species are solubilized or complexed simultaneously by the highly complex organic molecular species such as humic substances, such correlation becomes a difficult problem. The non-ionic [illegible] from all the experiments in this series can be taken to be of very similar composition. It is also not clear that the ionic and non-ionic species that are observed during the early days of culture growth are similar or



different (probably latter) from the ones observed towards the end of the experiment.

SORPTION OF TRACE ELEMENTS BY MARINE SEDIMENTS

Influence of organic matter on the sorption of trace elements by marine sediments is followed from the distribution of the elements in the trace element equilibrated sea-water and the added sediment.

Fresh coastal marine sediment (containing 3·76% organic matter and 24% acid-soluble CO_3) slurried with filtered sea-water (1 : 10 sediment : sea-water, weight : volume) and passed through 70 mesh sieve was taken for the experiment. The particle size was fairly uniform—less than 5 μ, 80%. Organic matter free sediment was obtained from this by repeated digestion of a part of this sieved slurry with H_2O_2 in presence of 0·05 N HCl at slightly elevated temperature (50-60° C.). The digested material was centrifuged, washed free of acid, equilibrated by repeated suspension in filtered sea-water and finally slurried in sea-water to give the same sediment : sea-water ratio as in the sieved original sediment slurry. ^{65}Zn, ^{54}Mn and ^{60}Co in chloride forms containing 100 μg of each of the trace element were used to find out their distribution coefficient, K_d, as described by Ganapathy *et al.*[18] Results are given in Table V.

The K_d values obtained are quite demonstrative of the profound influence of organic matter on the sorptive properties of the natural sediment. Similar experiments done with K, Ca, Sr did not indicate any difference in the K_d values between the original and organic matter free sediment. Earlier, Ganapathy *et al.*[18] also observed the influence of the organic matter in similar experiments with air-dried sediment sample. Their results are also given in the same table for comparison. Further, Ganapathy *et al.*[18] demonstrated that organic matter in the sediment has some small influence in Cs sorption. This is understandable in the light of observation that marine humic acid does not pick up Cs significantly in sea-water medium as observed by Koshy *et al.*[4]

It was thus of interest to extract the organic matter from different sediments to study the trace elements associated with the organic matter and the interactions of extract with metal ions.

TABLE V

Sorption of trace elements by coastal marine sediments in sea-water

Element	K_d†			
	Fresh sea-water sediment slurry		Air-dried sediment*	
	Original sediment	Organic matter free sediment	Original sediment	Organic matter free sediment
Zn ..	4453	18·5	6508	1868
Mn ..	28340	3·3	90	25
Co ..	8461	3·7	689	23

* Ganapathy *et al.*[18].

Carriers added : 100 μg/50 ml. for all elements in fresh sediment slurry,
200 μg/50 ml. for Zn and Mn for air-dried sediment.

$$\dagger\, K_d = \frac{\text{Activity sorbed by 1 g. of the sediment}}{\text{Activity in 1 ml. of sample filtrate}}.$$

HUMUS FROM MARINE SEDIMENTS

In the absence of a method for the isolation of humus substances in native form from sediments, alkali extraction procedure was adopted. A known quantity of a marine sediment was extracted with 0·2 N ($NaOH$ + Na_2CO_3) mixture (1 : 10 solid : solution) at 80° C. under constant stirring condition. The extract was allowed to stand and the supernatant was siphoned off, centrifuged (at 5500 G) and decanted. An aliquot of the extract was dialysed in cellophane bags till the dialysate was free of alkali. The product was made ammoniacal, filtered and dialysed again till the dialysate was free of ammonia. It was taken up in ammonia, filtered and stored as purified humus extracts stock (solid content 0·46 mg./ml.).

STATUS OF TRACE ELEMENTS IN HUMUS SUBSTANCES

An aliquot of the purified humus extract was passed through Dowex-50 × 8 (10 cm. × 1 cm.) NH_4^+ column first at the rate of 1 ml./min. and a part of the effluent was again passed through another similar column at the rate of 0·1 ml./min. The extract and the two effluents were wet-ashed with concentrated HNO_3 and analysed for metallic elements and Table VI gives the results obtained.

The extract contained significant quantities of PO_4, Al, Fe, Cu, Mn, Co, Zn, Mg and Ca. The ion exchange experiment showed that of the associated metallic elements, Ca was mostly exchangeable cationic, while Mg, Zn, Co and Mn were associated in cationic and non-cationic forms. Fe and Al are bound to the humus complex mostly in non-cationic forms.

The metallic elements are thus observed to be associated with the purified humus complex

TABLE VI
Trace elements in mildly purified humus extract

Element	Concentration in ppm		
	Before passing through Dowex-50	After first pass at 1 ml./min.	After second pass at 0·1 ml./min.
P as PO_4	10240	10240	10240
Al ..	1479	1479	1479
Fe ..	1395	1246	1246
Cu ..	2431	2304	2071
Mn ..	249	249	133
Co ..	132	120	60
Zn ..	748	302	207
Mg ..	1727	1727	617
Ca ..	8035	1127	337

Stability order : Al > Fe > Cu > Mn > Co ⩾ Mg > Zn > Ca.

TABLE VII
Ash and trace elements in humic and fulvic acids

Element	Concentration				
	Humic acid			Fulvic acid	
	Coastal	SS I*	SS II†	SS I	SS II
Ash (%)	1·0	2·94	2·99	2·6	..
SiO_2 ..	Nil	Nil	Nil	Nil	Nil
SO_4 ..	ND	ND	ND	ND	ND
PO_4 (ppm)	3226	3676	1248	10720	7754
Al ,,	3481	9864	2850	2454	13730
Fe ,,	179	1654	5920	ND	22390
Cu ,,	1380	1430	815	223	ND
Zn ,,	..	2520	1061	..	ND
Mg ,,	22	205	337	429	1395
Mn ,,	ND	23	408	178	779
Ca ,,	ND	ND	ND	515	ND
Sr ,,	ND	ND	ND	ND	ND
Cr ,,	83	15	..	ND	..
K ,,	81	132	ND	357	698

* 21 miles away from shore at 50 m depth.
† 70 miles away from shore at 90 m depth.

in different states of chemical combination and the relative abundance of cationic species and stability. The stabilities of Al, Fe and Cu complexes are the highest, the order of stability being Al > Fe > Cu > Mn > Co ⩾ Mg > Zn > Ca.

The purified humus extracts from different sediments were treated with HCl to pH 2 and centrifuged. The humic acid residue (dispersed in ammonia) and the supernatant fulvic acid fractions were further purified by prolonged electrodialysis raising the voltage progressively to 200 v till the breakdown of humic and fulvic acids was apparent from the appearance of colouration in the anion compartment.[4,5] Throughout the progress of electrodialysis PO_4 and amino-acids continued to appear in the anion compartment declining to very low values and then increased again when the visual breakdown of the acids were apparent. The product in the electrodialysis cell was taken up in ammonia and filtered. The products were wet-ashed as before and were observed to contain 1-3% ash. Results of trace metallic element analyses are given in Table VII.

It is significant to note that in spite of drastic electrodialysis that was continued for three months, neither the humic nor the fulvic acid fractions were observed to be ash-free. It seems inescapable to conclude that the trace elements present therein form integral part of the humic and fulvic acids. The acids breakdown (or decompose) on progressive removal of the metallic components. It is obvious that though humus substances are ion exchange materials, they hold many elements, specially bi- (Cu and Zn) and trivalent (Fe and Al), at different reactive sites with strong bonds not easily dissociable. Discussion by earlier workers on the nature and properties of humic acid centres mostly around the organic monomeric constituents and the entire structures are sought to be built on the basis of the concept of polymerization reactions amongst the organic monomers. However, it appears particularly important to take cognizance of the metallic ions present in the humus structure as participants in the build-up of the polymeric humus complex. The possibility of covalent binding of metallic ions with monomers in the humus complex needs to be investigated in greater detail.

Phosphate content is high in all the samples and of the total PO_4 content in the purified extract, only about 10% was observed to be associated with the humic acid fraction; and further, of the total weight of organic matter in the humus extract, only about 10% by weight was accounted for as fulvic fraction. Thus in the extract where treatments were mild, the PO_4 content per unit weight of fulvic acid was about 80 times of that in humic acid. We could not correlate the trace element content in the extracts with the phosphate content. The equivalence of the totality of the metallic elements present and the relative number of the atoms of metals are very much higher than the total PO_4 or P. That PO_4 is not in ionically bound state to the humus complex is also apparent from the high PO_4 content in the drastically purified (electrodialysed) humic and fulvic different (probably latter) from the ones observed towards the end of the experiment.

SORPTION OF TRACE ELEMENTS BY MARINE SEDIMENTS

Influence of organic matter on the sorption of trace elements by marine sediments is followed from the distribution of the elements in the trace element equilibrated sea-water and the added sediment.

Fresh coastal marine sediment (containing 3·76% organic matter and 24% acid-soluble CO_3) slurried with filtered sea-water (1 : 10 sediment : sea-water, weight : volume) and passed through 70 mesh sieve was taken for the experiment. The particle size was fairly uniform—less than 5 μ, 80%. Organic matter free sediment was obtained from this by repeated digestion of a part of this sieved slurry with H_2O_2 in presence of 0·05 N HCl at slightly elevated temperature (50-60° C.). The digested material was centrifuged, washed free of acid, equilibrated by repeated suspension in filtered sea-water and finally slurried in sea-water to give the same sediment : sea-water ratio as in the sieved original sediment slurry. ^{65}Zn, ^{54}Mn and ^{60}Co in chloride forms containing 100 μg of each of the trace element were used to find out their distribution coefficient, K_d, as described by Ganapathy *et al.*[18] Results are given in Table V.

The K_d values obtained are quite demonstrative of the profound influence of organic matter on the sorptive properties of the natural sediment. Similar experiments done with K, Ca, Sr did not indicate any difference in the K_l values between the original and organic matter free sediment. Earlier, Ganapathy *et al.*[18] also observed the influence of the organic matter in similar experiments with air-dried sediment sample. Their results are also given in the same table for comparison. Further, Ganapathy *et al.*[18] demonstrated that organic matter in the sediment has some small influence in Cs sorption. This is understandable in the light of observation that marine humic acid does not pick up Cs significantly in sea-water medium as observed by Koshy *et al.*[4]

It was thus of interest to extract the organic matter from different sediments to study the trace elements associated with the organic matter and the interactions of extract with metal ions.

HUMUS FROM MARINE SEDIMENTS

In the absence of a method for the isolation of humus substances in native form from sediments, alkali extraction procedure was adopted. A known quantity of a marine sediment was extracted with 0·2 N ($NaOH + Na_2CO_3$) mixture (1 : 10 solid : solution) at 80° C. under constant stirring condition. The extract was allowed to stand and the supernatant was siphoned off, centrifuged (at 5500 G) and decanted. An aliquot of the extract was dialysed in cellophane bags till the dialysate was free of alkali. The product was made ammoniacal, filtered and dialysed again till the dialysate was free of ammonia. It was taken up in ammonia, filtered and stored as purified humus extracts stock (solid content 0·46 mg./ml.).

TABLE V
Sorption of trace elements by coastal marine sediments in sea-water

Element	K_d†			
	Fresh sea-water sediment slurry		Air-dried sediment*	
	Original sediment	Organic matter free sediment	Original sediment	Organic matter free sediment
Zn ..	4453	18·5	6508	1868
Mn ..	28340	3·3	90	25
Co ..	8461	3·7	689	23

* Ganapathy *et al.*[18].

Carriers added : 100 μg/50 ml. for all elements in fresh sediment slurry,
200 μg/50 ml. for Zn and Mn for air-dried sediment.

$$\dagger K_d = \frac{\text{Activity sorbed by 1 g. of the sediment}}{\text{Activity in 1 ml. of sample filtrate}}$$

STATUS OF TRACE ELEMENTS IN HUMUS SUBSTANCES

An aliquot of the purified humus extract was passed through Dowex-50 × 8 (10 cm. × 1 cm.) NH_4^+ column first at the rate of 1 ml./min. and a part of the effluent was again passed through another similar column at the rate of 0·1 ml./min. The extract and the two effluents were wet-ashed with concentrated HNO_3 and analysed for metallic elements and Table VI gives the results obtained.

The extract contained significant quantities of PO_4, Al, Fe, Cu, Mn, Co, Zn, Mg and Ca. The ion exchange experiment showed that of the associated metallic elements, Ca was mostly exchangeable cationic, while Mg, Zn, Co and Mn were associated in cationic and non-cationic forms. Fe and Al are bound to the humus complex mostly in non-cationic forms.

The metallic elements are thus observed to be associated with the purified humus complex

TABLE VI

Trace elements in mildly purified humus extract

Element	Concentration in ppm		
	Before passing through Dowex-50	After first pass at 1 ml./min.	After second pass at 0·1 ml./min.
P as PO_4	10240	10240	10240
Al ..	1479	1479	1479
Fe ..	1395	1246	1246
Cu ..	2431	2304	2071
Mn ..	249	249	133
Co ..	132	120	60
Zn ..	748	302	207
Mg ..	1727	1727	617
Ca ..	8035	1127	337

Stability order : Al > Fe > Cu > Mn > Co ⩾ Mg > Zn > Ca.

in different states of chemical combination and the relative abundance of cationic species and stability. The stabilities of Al, Fe and Cu complexes are the highest, the order of stability being Al > Fe > Cu > Mn > Co ⩾ Mg > Zn > Ca.

The purified humus extracts from different sediments were treated with HCl to pH 2 and centrifuged. The humic acid residue (dispersed in ammonia) and the supernatant fulvic acid fractions were further purified by prolonged electrodialysis raising the voltage progressively to 200 v till the breakdown of humic and fulvic acids was apparent from the appearance of colouration in the anion compartment.[4,5] Throughout the progress of electrodialysis PO_4 and amino-acids continued to appear in the anion compartment declining to very low values and then increased again when the visual breakdown of the acids were apparent. The product in the electrodialysis cell was taken up in ammonia and filtered. The products were wet-ashed as before and were observed to contain 1-3% ash. Results of trace metallic element analyses are given in Table VII.

TABLE VII

Ash and trace elements in humic and fulvic acids

Element	Concentration				
	Humic acid			Fulvic acid	
	Coastal	SS I*	SS II†	SS I	SS II
Ash (%)	1·0	2·94	2·99	2·6	..
SiO_2 ..	Nil	Nil	Nil	Nil	Nil
SO_4 ..	ND	ND	ND	ND	ND
PO_4 (ppm)	3226	3676	1248	10720	7754
Al ,,	3481	9864	2850	2454	13730
Fe ,,	179	1654	5920	ND	22390
Cu ,,	1380	1430	815	223	ND
Zn ,,	..	2520	1061	..	ND
Mg ,,	22	205	337	429	1395
Mn ,,	ND	23	408	178	779
Ca ,,	ND	ND	ND	515	ND
Sr ,,	ND	ND	ND	ND	ND
Cr ,,	83	15	..	ND	..
K ,,	81	132	ND	357	698

* 21 miles away from shore at 50 m depth.
† 70 miles away from shore at 90 m depth.

It is significant to note that in spite of drastic electrodialysis that was continued for three months, neither the humic nor the fulvic acid fractions were observed to be ash-free. It seems inescapable to conclude that the trace elements present therein form integral part of the humic and fulvic acids. The acids breakdown (or decompose) on progressive removal of the metallic components. It is obvious that though humus substances are ion exchange materials, they hold many elements, specially bi- (Cu and Zn) and trivalent (Fe and Al), at different reactive sites with strong bonds not easily dissociable. Discussion by earlier workers on the nature and properties of humic acid centres mostly around the organic monomeric constituents and the entire structures are sought to be built on the basis of the concept of polymerization reactions amongst the organic monomers. However, it appears particularly important to take cognizance of the metallic ions present in the humus structure as participants in the build-up of the polymeric humus complex. The possibility of covalent binding of metallic ions with monomers in the humus complex needs to be investigated in greater detail.

Phosphate content is high in all the samples and of the total PO_4 content in the purified extract, only about 10% was observed to be associated with the humic acid fraction; and further, of the total weight of organic matter in the humus extract, only about 10% by weight was accounted for as fulvic fraction. Thus in the extract where treatments were mild, the PO_4 content per unit weight of fulvic acid was about 80 times of that in humic acid. We could not correlate the trace element content in the extracts with the phosphate content. The equivalence of the totality of the metallic elements present and the relative number of the atoms of metals are very much higher than the total PO_4 or P. That PO_4 is not in ionically bound state to the humus complex is also apparent from the high PO_4 content in the drastically purified (electrodialysed) humic and fulvic acids. It appears that PO_4 is also involved in the polymerization giving rise to the organic complex. No silica or sulphate were detected in the samples analysed.

INTERACTION OF TRACE ELEMENTS WITH HUMUS SUBSTANCES

Solubilization of trace elements by humic and fulvic acids in ammoniacal medium was studied using $^{65}Zn^{+2}$, $^{54}Mn^{+2}$, $^{60}Co^{+2}$ and $^{59}Fe^{+3}$ in chloride forms containing respective inactive carriers and also using $^{234}Th^{+4}$, Natu^{+6} and $^{239\text{-}240}Pu^{+6}$ in nitrate forms.[5] The sample solutions with tracers were kept for a week with intermittent shaking, filtered and an aliquot of the filtrate was analysed for the trace element. Another aliquot of the filtrate was passed through a Dowex ($-50 \times 8\ NH_4$ $-0 \cdot 2$ ml./min.) column, the effluent and washings were also analysed for the element. Results are presented in Table VIII. Behaviour of humus bound metallic ions on passing through an anion column could not be investigated since the host materials, *viz.*, humic and fulvic acids were themselves anionic.

Humic and fulvic acids solubilize the elements significantly and fulvic acid solubilizes more than the humic acid. The nature of the trace element complexes with humic and fulvic acids appears to be similar. Bivalent elements form cationic and non-cationic complexes while tri- and tetravalent ions form mainly non-cationic complexes.

TABLE VIII

Solubilization of certain metal ions by and the nature of the metallic complexes of marine humic and fulvic acids

Element		Solubilization (mg./g.)		% Non-cationic in solubilized fraction	
		Humic acid	Fulvic acid	Humic acid	Fulvic acid
Zn	..	5·97	41·51	12·4	0
Mn	..	..	85·7	100†	66
Co	..	33·8*	22·8*	64	35
Fe	..	15·4	34·22	100	90
Zr-Nb	..	..	..	95	94
Th	..	2·85	8·72	100	100
U	..	6·0	..	70	..
Pu	..	0·042 $\times 10^{-3}$	0·14 $\times 10^{-3}$	100	100

Humic acid used: 0·95 mg. Fulvic acid used: 0·11 mg.

Trace element used:

H.A.: Zn, 21·92 μg; Co, 50 μg; Fe, 53·3 μg; Th, 3 μg; U, 9·8 μg.

F.A.: Zn, 14·62 μg; Mn, 10 μg; Co, 10 μg: Fe, 21·3 μg; Th, 1·83 μg.

* Non-cationic fraction only, † Sorbed on humic acid in sea-water.

DISCUSSION

Quantitative analyses of the monomeric constituents of humic and fulvic acids are not yet possible and in the present work it was not possible to effect complete degradation or hydrolysis of the humus material. Presence of amino-acids and sugars (including pentose) in the hydrolysates of humus substances was confirmed. The presence of purines and pyrimidines has also been qualitatively indicated. Our attempts to estimate the amino-acids and sugar constituents in the material did not succeed.

Understanding of the nature of the binding of trace elements with different reactive groups in the humus complex and quantitative assessment of the stability and their variation with the source of the material shall have to wait further careful investigation. In our investigations we could only observe that alkaline earth elements such as Sr, Ba, Ra and possibly Ca are quantitatively ion-exchangeable and fractions of the trivalent elements present in the dialysed humus extract and in sea-water soluble material* are ion-exchangeable.[4,5,7,23] Other bivalent elements are present in the humus and in the dissolved material in different states of combination, *viz.*, cationic, anionic and non-ionic. Presence of PO_4 is very significant and there are indications that pentoses and purine-pyrimidines are present in the material besides the amino-acids, hexose sugars, etc. Pillai *et al.*[24] have produced evidence of the presence of dissolved nucleic acids in sea-water. Role of this component in the organo-metallic interactions observed in sea-water is still to be investigated.

It is also very significant that it was not possible to remove the trace elements from humic or fulvic acid without degrading them to low molecular weight fragments. There are statements in the literature[25] regarding ash-free humic acid. However, this could not be confirmed in the material extracted by the procedure adopted in the present work. No investigation was undertaken on the humus material.

---

* Dissolved organic matter and soluble humus in sea-water.

1. Skirrow, G., In *Chemical Oceanography*, Eds. Riley, J. P. and Skirrow, G., Academic Press, London–New York, 1965, **1**, 227.
2. Skopintsev, B. A., *Preprints Intern. Oceanogr. Congr.*, A.A.A.S., **1959**, p. 953.

3. Duursma, E. K., In *Chemical Oceanography*, Eds. Riley, J. P. and Skirrow, G., Academic Press, London–New York, **1965**, **1**, 433.
4. Koshy, E. and Ganguly, A. K., *BARC-402*, 1969.
5. Desai, M. V. M. and Ganguly, A. K., *BARC-468*, 1970.
6. —, Koshy, E. and Ganguly, A. K., *Curr. Sci.*, 1969, **38**, 107.
7. —, — and —, *Ibid.*, 1969, **38**, 555.
8. Krauskopf, K. B., *Geochim et Cosmochim Acta*, 1956, **9**, 1.
9. Burton, J. D., Personal Communication, 1969.
10. Goldberg, E. D., In *Chemical Oceanography*, Eds. Riley, J. P. and Skirrow, G., Academic Press, London–New York, **1965**, **1**, 433.
11. Lewis, G. J. and Goldberg, E. D., *J. Mar. Res.*, 1955, **13**, 183.
12. Laevastu, T. and Thompson, T. C., *Ibid.*, 1958, **16**, 192.
13. Alexander, J. E. and Corcoran, E. F., *Limnarl. Oceanogr.*, 1967, **12**, 236.
14. Rona, E., Hood, D. W., Muse, L. and Puglio, B., *Ibid.*, 1962, **7**, 201.
15. Slowey, J. F., Jeffrey, L. M. and Hood, D. W., *Nature*, 1967, **214**, 377.
16. Burton, J. D., *Ibid.*, 1966, **212**, 976.
17. Williams, P. M., *IMR-68-8*, 1968, Vol. 2.
18. Ganapathy, S., Pillai, K. C. and Ganguly, A. K., *BARC-376*, 1968.
19. Koshy, E., Desai, M. V. M. and Ganguly, A. K., *Curr. Sci.*, 1969, **38**, 582.
20. Basu, A. N., Mukherjee, D. C. and Mukherjee, S. K., *J. Ind. Soc. Soil. Sci.*, 1964, **12**, 311.
21. Schnitzer, M. and Skinner, S. I. M., *Soil Sci.*, 1963, **99**, 86.
22. Randhawa, N. S. and Broadbent, F. E., *Ibid.*, 1965, **99**, 295.
23. Desai, M. V. M., Mathew, E. and Ganguly, A. K., *Curr. Sci.*, 1970, **39**, 429
24. Pillai, T. N. V. and Ganguly, A. K., *Ibid.*, 1970, **39**, 501.
25. Eloff, J. N., *S. African Jour. Agr. Sci.*, 1965, **8**, 673.

VIRAL ANTIGENS IN THE BAI STRAIN A (AVIAN MYELOBLASTOSIS) VIRUS ASSOCIATED MYELOBLASTS AND CHICK EMBRYO FIBROBLASTS

P. R. RAO*
Department of Zoology, Post-Graduate Centre, Warangal-1, A.P.

CHICKEN leukosis viruses are released like myxoviruses by a budding process from cellular membranes and have been shown to contain cellular material in their constitution. Avian myeloblastosis virus (AMV) which causes leukemia in chickens picks up ATPase of cellular origin as it buds from myeloblast cell surface and when this same virus is produced by chick embryo fibroblasts (CEF), the viruses do not show ATPase activity.[1] Beauer[2] has also shown that in addition to ATPase, an RNA digesting enzyme associated with myeloblast virus is lacking in fibroblast virus. Differences in the sedimentation behaviour during CsCl density gradient centrifugations were also observed between myeloblast and fibroblast virus of AMV.[3] It was then of interest to see if there will be an antigenic variation of viral components present in fibroblast and myeloblast cells producing this virus. To study this we have analysed the viral components of the myeloblast host cell using the ouchterlony technique of double diffusion with antisera produced against detergent split AMV and recently shown avian tumor virus group specific (GS) hamster antiserum.[4] A similar analysis was done on chicken fibroblast cells infected with AMV to see if identical antigens are present in these two different host cells.

Myeloblast cells collected from leukemic chickens[5] and washed twice with 0·01 M phosphate buffered saline (PBS), pH 7·4, were stored at − 20° C. until needed. Primary cultures of RIF-free[6] chick embryo fibroblast were infected with a multiplicity of 100 virus particles per cell. After five days incubation at 37° C., cells were collected, washed twice with PBS and stored as were the myeloblasts. 1 ml. of frozen and thawed myeloblasts or CEF diluted to 10 ml. with PBS was homogenized with a glass pestle. The homogenate was centrifuged to remove nuclear, mitochondrial and microsomal fractions.[7] The supernatant obtained after these centrifugations is the soluble fraction used in this study.

Purified AMV pellets[8] containing 10^{12} particles as determined by particle[9] count were dissolved in 1 ml. of PBS with sodium dodecyl sulfate (SDS) or sodium deoxycholate (SDC) in 0·5% concentration. Excess SDS was removed by adding a drop of KCl and sedimenting the precipitate. Rabbits were inoculated with these virus split products according to Eckert *et al.*[10] A part of each serum was absorbed twice for 1 hr. at 37° C. and finally at 4° C. for 16 hr. with a mixture of normal chick liver, kidney and spleen. Hamster serum pool used in this study was obtained from hamsters bearing transplanted Schmidt-Ruppin tumours[11] and did not react with normal chick tissue. All sera were inactivated at 56° C. for 30 min. Diffusion studies were made with immunoplates (Pattern B, Hyland Laboratories, Los Angeles, U.S.A.). Plates prepared with antigen and antisera were incubated at 37° C. in a moist chamber for 48–72 hr., washed for 1–2 days and stained with Amido-black. The stained preparations were then photographed.

---

* This work was done while the author was at Duke University Medical Centre, U.S.A.

Figure 1 *a* shows the precipitin lines obtained with different sera when reacted against the myeloblast soluble fraction. Two precipitin lines were seen with the hamster serum, one of which showed identity with the respective single lines observed with chick tissue absorbed SDC and SDS rabbit sera. However, on some occasions a second faint line continuous with the second line of hamster serum was noticed against the chick tissue absorbed SDC rabbit antiserum. Unabsorbed SDC serum showed two distinct and one very faint line but only one distinct and one very faint line formed against the unabsorbed SDS serum. Only one of the lines formed against both SDC and SDS unabsorbed sera was continuous with the single line produced against the absorbed sera. This indicates that the myeloblast soluble fraction contains a component(s) which gives identical reaction with antibodies of both hamster and absorbed rabbit sera. The faint line present with both SDS and SDC unabsorbed rabbit sera was difficult to analyse due to faint and inconsistent appearance. However, the faint lines present with both SDS and SDC unabsorbed rabbit sera were continuous when present.

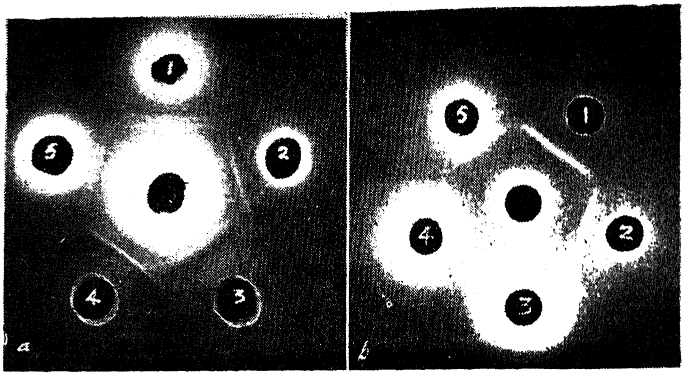


FIG. 1 *a–b* (*a*) The centre well contained myeloblast soluble fraction. Antisera in the outer wells are of the following order: (1) Hamster serum (2) absorbed and (3) unabsorbed SDC rabbit sera, (4) unabsorbed and (5) absorbed SDS rabbit sera. (*b*) The centre well contained the myeloblastosis virus-infected chicken embryo fibroblast soluble fraction. The outer wells had the same antisera in a similar order as in (*a*).

Fibroblast soluble fraction (Fig. 1 *b*) was run against the antisera in the same sequence. Only one precipitin line formed against all sera, each line showing identity with the next one. Occasionally, two lines were seen with hamster serum and a faint second line with absorbed SDC serum. The additional lines which were formed with unabsorbed SDS and SDC sera against myeloblast soluble fraction were absent in the fibroblast soluble fraction. However, when anti-chick tissue serum was allowed to react with normal or infected fibroblasts, precipitin lines did form. These studies then indicate that the viral antigens of cellular origin present in myeloblast cells are absent in fibroblast cells.

The comparative study of the viral antigens present in the myeloblast and fibroblast cell has thus revealed a difference although infected with the same virus. The chick tissue components of the AMV present in the myeloblast are absent in the fibroblast host cells and evidently a different set of fibroblast components are incorporated in the AMV obtained from these cells. These studies and those already mentioned clearly demonstrate that avian myeloblastosis virus incorporates in itself different host material as it buds from cells of different origin.

---

1. De THE, G., *Natl. J. Cancer Inst. Monogr.*, 1964, **17**, 651.
2. Bauer, H., *Z. Naturforsch.*, 1966, **21 B**, 453.
3. Allen. D. W., *Biochim. Biophys. Acta*, 1966, **114**, 606.
4. Heubner, R. J., Armstrong, D., Okuyan, M., Sharma, P. S. and Turner, H. C., *Proc. Natl. Acad. Sci., U.S.A.*, 1964, **51**, 742.
5. Eckert, E. A., Beard, D. and Beard, J. W., *J. Natl. Cancer Inst.*, 1954, **14**, 1055.
6. Rubin, H., *Proc. Natl. Acad. Sci., U.S.A.*, 1960, **46**, 1105.
7. Sverak, L., Beaudreau, G. S. and Beard, J. W., *J. Natl. Cancer. Inst.*, 1962, **29**, 355.
8. Bonar, R. A. and Beard, J. W., *Ibid.*, 1959, **23**, 183.
9. Sharp, D. G. and Beard, J. W., *Proc. Soc. Exptl. Biol. Med.*, 1952, **81**, 75.
10. Eckert, E. A., Rott, R. and Schafer, W., *Virology*, 1964, **24**, 426.
11. Ahlstrom, C. G. and Forsby, N., *J. Exptl. Med.*, 1962, **115**, 839.

LETTERS TO THE EDITOR

BROMINATION OF ANISOLE CATALYSED BY ZINC CHLORIDE, IODINE BROMIDE AND OTHER SALTS

In the bromination of aromatic compounds, halogen carriers such as iodine and the anhydrous chlorides of iron, zinc and aluminium are often used as catalysts.[1] Iodine bromide has been shown to be the effective catalyst in a recent study[2] of the bromination of anisole in acetic acid in the presence of added iodine. The bromination of aromatic hydrocarbons in acetic acid has a fractional order (between 2 and 3) which makes the interpretation of the effect of zinc chloride in this reaction complex.[3]

In the present investigation we have used 85% aqueous acetic acid medium, in which the bromination of anisole shows a simple second order kinetics.[4] When zinc chloride (0·001 M) was added to the reaction mixture, the rate of bromination was found to increase. It was found that on increasing the concentration of zinc chloride there was a steady increase in the observed second order rate constant. A similar effect was also noticed in the presence of iodine bromide and sodium chloride.

The rate of bromination of anisole in the presence of these added salts can be expressed as follows:

$$-\frac{d(Br_2)}{dt} = k\,(ArH)\,(Br_2) + k_c\,(ArH)\,(Br_2)\,(A)$$

where A is the added salt, and k and k_c represent the rate constants for the uncatalysed and catalysed reactions, respectively. The above equation can be reduced to the following:

$$k_2 = k + k_c\,(A)$$

where k_2 is the observed second order rate constant. The plot of k_2 *versus* A was found to be a straight line in each case. From the slope and intercept of these lines, k_c and k were calculated and the values are given in Table I.

From the last column of Table I it is seen that the relative reactivity of the added salts is in the following order:

$$IBr > ZnCl_2 > NaCl,$$

TABLE I

Bromination of anisole in the presence of added salts

Anisole: $5{\cdot}0 \times 10^{-4}$ M Solvent: 85% aq. HOAc
Bromine: 5×10^{-4} M Temp.: 30·0±0·1° C.

Added salt	Conc. range $\times 10^4$ (M)	k (lit/mole/sec.)	k_c (lit²/mole²/sec.)	Relative reactivity
NaCl ..	5·0–750	11·5	349	1·0
$ZnCl_2$ ..	5·0–500	14·0	1250	3·6
IBr ..	1·5– 30	9·5	9067	26·0

These catalysts probably facilitate the removal of the bromide ion from the anisole-bromine activated complex in the form of IBr_2^-, $ZnCl_2Br^-$ and $NaClBr^-$.

The addition of zinc bromide (0·0005–0·100 M), zinc acetate (0·0005–0·075 M) and sodium acetate (0·0025–0·075 M) did not bring about any significant change in the rate of bromination of anisole in 85% aqueous acetic acid. In the presence of potassium bromide (0·003–0·222 M) and sodium bromide (0·006–0·131 M), however, the rate of bromine consumption was found to decrease as the bromide ion concentration was increased, due to the conversion of free molecular bromine into the less reactive tribromide ion[5]:

$$Br_2 + Br^- \rightleftharpoons Br_3^-.$$

The authors thank the Council of Scientific and Industrial Research, New Delhi, for a grant in support of this research.

Dept. of Chemistry, N. S. GNANAPRAGASAM.
Loyola College, N. JOSEPH.
Madras-34, *November* 9, 1970.

---

1. Braendlin, H. P. and McBee, E. T., In *Friedel-Crafts and Relatad Reactions*, Ed. Olah, G. A., Interscience Publishers, New York, 1964, **3**, Part 2, 1530.
2. Kothandaraman, G., Rajaram, J. and Kuriacose, J. C., *Proc. Ind. Acad. Sci.*, 1970, **72 A**, 144.
3. Andrews, L. J. and Keefer, R. M., *J. Amer. Chem. Soc*, 1956, **78**, 4549.
4. Yeddanapalli, L. M. and Gnanapragasam, N. S., *J. Ind. Chem. Soc.*, 1959, **36**, 745.
5. Zimmerman, U. P. and Berliner, E., *J. Amer. Chem. Soc.*, 1962, **84**, 3953.

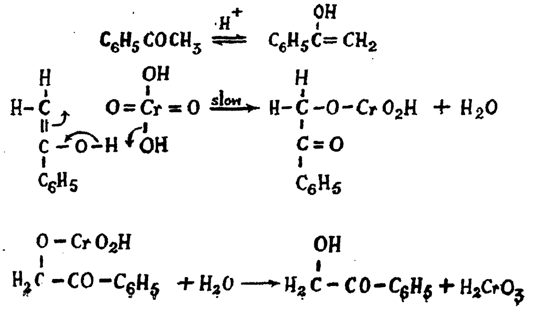
MECHANISM OF THE CHROMIC ACID OXIDATION OF ACETOPHENONE

A SYSTEMATIC study of the oxidation of ketones by chromic acid was undertaken by the authors to investigate the role of enol form in the oxidation process. The present communication is about the results of oxidation of acetophenone by chromic acid.

The reactions were carried out in 50% acetic acid solution (v/v) and followed by estimating unreacted chromium (VI) at different time intervals iodometrically. The rate at which Cr(VI) disappears followed first order rate laws but first order rate constant decreases with increase in initial concentration of Cr(VI) and shows that reaction is strictly of first order with respect to acid chromate ion, $HCrO_4^-$. The rate showed a first order dependence on acetophenone and hydrogen ion individually. The oxidation rate increases ($k = 1{\cdot}98\text{-}29{\cdot}8 \times 10^{-6}$ l^2 $mole^{-2}$ $sec.^{-1}$) with the proportion of acetic acid in solution (40-70%) at 30° C. The reaction was studied at different temperatures and activation parameters were calculated.

The enolisation rate of acetophenone was measured by bromination method and is of first order with respect to the ketone and hydrogen ions individually, and of zero order to bromine. The higher concentration of acetic acid (30-80%) results in increased enolisation rate at 30° C. ($k_2 = 1{\cdot}1 \times 10^{-4}\text{–}1{\cdot}5 \times 10^{-4}$ l. $mole^{-1}$ $sec.^{-1}$).

Recently, Rocek and Riehl[1] proposed that the oxidation of isobutyrophenone by chromic acid proceeds *via* enolisation. The kinetics of the oxidation and enolisation of acetophenone are very much similar and the enol form is most likely intermediate in the oxidation process. This also accords with suggestion of Best, Littler and Waters.[2] Enol form may be oxidised by the chromate-ester mechanism but enols are acids of pK comparable to phenols[2] and hence the attack of chromic acid on the enol is best represented as a concerted process :



$$C_6H_5COCH_3 \overset{H^+}{\rightleftharpoons} C_6H_5C(OH){=}CH_2$$

$$H_2C(O{-}CrO_2H){-}CO{-}C_6H_5 + H_2O \longrightarrow H_2C(OH){-}CO{-}C_6H_5 + H_2CrO_3$$

The proposed mechanism explains all the observed data.

The energy of activation, entropy of activation and free energy of activation as calculated from results at different temperatures are 16·6 K. cals. mole.$^{-1}$, $-29{\cdot}2$ e.u. and 25·5 K. cals. mole^{-1} respectively. The corresponding values for enolisation reaction are 20·1 K. cals. mole^{-1}, $-11{\cdot}0$ e.u. and 23·4 K. cals. mole^{-1} respectively.

ω-Hydroxyacetophenone was mainly the identified product[3] and a 2 : 3 stoichiometry for Δ CrO_4^{--}/Δ acetophenone is evaluated by estimating Cr(VI).

Dept. of Chemistry, S. K. TANDON.*
University of Jodhpur, K. K. BANERJI.
Jodhpur (India), G. V. BAKORE.
November 3, 1970.

---

* Present Address : Department of Chemistry, Government College, Ajmer (Raj.), India.

1. Rocek, J. and Riehl, A., *J. Amer. Chem. Soc.*, 1967, **89**, 6691.
2. Best, P. A., Littler, J. S. and Waters, W. A., *J., Chem. Soc.* (*London*), 1962, p. 822.
3. Feigl, F., *Spot Tests in Organic Chemistry*, Elsevier Amsterdam, 1966, p. 176.

CRYSTALLINE CHEMICAL COMPONENTS OF THE FLOWERS OF *ADHATHODA VASICA*

EXAMINATION of the flowers of *Adhathoda vasica* Nees. (Acanthaceae) by earlier workers led to the isolation of vasicine, vasicinine, triatricontane, β-sitosterol[1,2] and luteolin.[3] The present note describes the results obtained in the course of a more thorough investigation of the non-alkaloidal components.

The fresh flowers (collected round the Delhi University Campus) were extracted with boiling alcohol and the concentrated extract was successively extracted with petroleum ether, ether, ethyl acetate and *n*-butanol. From the petroleum ether extract, besides triatricontane and β-sitosterol reported earlier,[2] α-amyrin and β-sitosterol-D-glucoside were also isolated (by column chromatography over silica gel). These were characterised by the usual methods including preparation of derivatives and permethylation and hydrolysis of the last compound to yield 2, 3, 4, 6-tetra-O-methyl-D-glucose.

From the ether extract kaempferol and quercetin were isolated by column chromatography and they were characterised by their derivatives and spectral data.

The ethyl acetate and n-butanol extracts which contained five and six components respectively (according to TLC) were subjected to column chromatography over silica gel and to further purification by preparative TLC. Two crystalline flavonoid glycosides $C_{21}H_{20}O_{11}$, m.p. 176-78 and $C_{27}H_{30}O_{16}$, m.p. 198-99 were thus obtained from both the extracts. Both of them yielded kaempferol and D-glucose on acid hydrolysis. Permethylation followed by hydrolysis yielded 5, 7, 4' tri-O-methylkaempferol and 2, 3, 4, 6 tetra-O-methyl-D-glucose in both cases; but the second glycoside yielded 3, 4, 6-tri-O-methyl-D-glucose in addition. These led to the identification of the two glycosides as kaempferol 3-β-D-glucoside[1] and kaempferol-3-sophoroside[2] respectively. The spectral data of the two glycosides, their log ε values and the shifts with the reagents generally employed in the study of flavonoids agreed with these structures. The mono-glucoside was present in larger quantities in the ethyl acetate extract and the sophoroside in the n-butanol extract.

The authors thank Prof. T. R. Seshadri, F.R.S., for his kind interest in this study.

Dept. of Chemistry, S. Rangaswami.
University of Delhi, R. Seshadri.
Delhi-7, November 11, 1970.

---

1. Ikram, M., Ehsanul Haq, M. and Warsi, S. A., *Pakistan J. Sci. Ind. Res.*, 1965, **8**, 78.
2. —, — and —, *Ibid.*, 1967, **10**, 224.
3. Nair, A. G. R., Nagarajan, S. and Subramanian, S. S., *Curr. Sci.*, 1965, **34**, 79.
4. Egger, V. K., *Z. Naturforsch.*, 1962, **17 B**, 139.
5. Birkofer, V. L. and Kaiser, C., *Ibid.*, 1962, **17 B**, 359.

BITTER PRINCIPLES OF *PHYSALIS MINIMA* AND *PHYSALIS PERUVIANA*

In recent years, there has been some special interest in the study of the chemical components of *Physalis* species (Family Solanaceae) in view of the isolation of three novel crystalline bitter principles, Physalin A, B and C with 13, 14-seco-16, 24 cyclo C 28 steroidal structure from *Physalis alkekengi* var. *francheti*[4,5]. In continuation of our earlier work on *P. angulata*,[3] we have made a detailed chemical investigation of the two common Indian species, *P. minima* Linn and *P. peruviana* Linn. Our results are recorded in brief; besides the known compounds Physalin B from *P. minima* and Physalin A from *P. peruviana*, we have isolated three new bitter substances.

Fresh aerial parts of *P. minima* collected locally (July 1970) were extracted with hot 95% ethanol three times and the total alcoholic extract concentrated *in vacuo* to remove all the organic solvent. The aqueous concentrate was repeatedly shaken with *n*-hexane, ether and chloroform in succession and the different fractions were separately studied. The residue from the ether extract (positive steroidal colour reactions) was taken up in minimum quantity of chloroform and chromatographed on neutral alumina (E. Merck) and eluted with petroleum ether, benzene, benzene-chloroform mixture (9 : 1, 3 : 1, and 1 : 1), followed by pure chloroform. The mixed residue from the benzene-chloroform 9 : 1 and 3 : 1 eluates when crystallised twice from acetone, yielded colourless prisms, m.p. 248-49 (yield, 0·05%), $C_{28}H_{30}O_9$, CH_3COCH_3 with spectral properties: UV, $\lambda_{max.}$ EtOH 222 nm (ϵ 10,000) (α, β-unsaturated carbonyl); IR, 3400 cm.$^{-1}$ (OH), 1780, 1758, 1740 cm.$^{-1}$ (γ-lactone, five-membered ring lactone, δ-lactone), 1655 cm.$^{-1}$ (cyclo-hexenone); TLC, single, R_f: 0·86 (EtOAc : C_6H_6 7 : 3) and 0·8 ($CHCl_3$: acetone 9 : 1) (silica gel, E. Merck, identified by exposure to iodine vapour); MS: prominent peak, m/e 510. The substance when crystallised from methanol melted at 270-71°. From the above data, it was identified as Physalin B[4,5] and the identity was confirmed by co-TLC, m.m.p. and direct comparison with an authentic sample. The mixed residue from benzene-chloroform 1 : 1 and chloroform eluates when crystallised thrice from methanol yielded colourless needles, m.p. 183-85° (yield, 0·01%), TLC, single, R_f: 0·70 and 0·65, UV, λ_{max} EtOH 223 nm (ϵ 17400), Mol. Wt. 466 by mass spectrometry, corresponding to $C_{27}H_{30}O_7$. This appears to be a new bitter Physalin-type substance.

The dried leaves of *P. peruviana* collected from the Ooty hills (August 1970) were extracted and processed as above. The residue from the benzene eluate on recrystallisation twice from hot benzene yielded colourless prisms, m.p. 186-87° (yield, 0·1%), TLC, single, R_f: 0·44 and 0·23. This also could not be identified with any of the known Physalins. The residue from the benzene-chloroform 3 : 1 eluate, when crystallised from acetone, yielded colourless micro-crystals, m.p. 265° (yield, 0·05%), $C_{28}H_{30}O_{10}$, TLC, single, R_f: 0·50 and 0·19. This was identified as Physalin[4,5], and the identity confirmed by direct comparison, m.m.p. and co-TLC with an authentic sample. The residue from the chloroform eluate yielded colourless prisms, m.p. 212° (acetone), TLC, single, R_f: 0·30 and 0·13. This again appears to be a new Physalin-type substance.

We are grateful to Prof. Dr. T. Matsuura, Department of Synthetic Chemistry, Kyoto University, Japan, for the authentic samples of Physalin A and B and the spectral data. We thank the Director, United Planters' Association of South India, for kindly arranging the supply of *P. peruviana* and the Principal, J.I.P.M.E.R., for encouragement.

Depts. of Chemistry S. Sankara Subramanian.
and Pharmacol., P. D. Sethi.
J.I.P.M.E.R.,
Pondicherry-6, *November* 12, 1970.

---

1. Matsuura, T., Kawai, M., Nakashima, R. and Batsugan, Y., *Tetrahedron Letters*, **1969**, No. **14**, **1083**.
2. — and Kawai, M., *Ibid.*, **1969**, No. **22**, **1765**.
3. Kawai, M. and Matsuura, T., *Tetrahedron*, **1970**, **26**, **1743**.
4. Subramanian, S. S. and Sethi, P. D., *Indian J. Pharm.*, 1970, **32**, 163.
5. Matsuura, T., Kawai, M, Nakashima, R. and Batsugan, Y., *J. Chem. S.*, 1970 *c*, p. 664.

ANTI-INFLAMMATORY PRINCIPLES OF *VANDA ROXBURGHII*

Vanda roxburghii R. Br. (*Orchidaceae, Rasna*),[1] a common parasitic plant, is extensively used in the Indian indigenous systems of medicine for its beneficial actions in piles, rheumatism, sciatica and various other inflammatory and nervous diseases. Das *et al.*[2] reported the presence of β-sitosterol, γ-sitosterol and two long-chain fatty compounds in the whole plants. In an experimental study Prasad *et al.*[3] observed that the total steroids of *V. roxburghii* possessed highly significant anti-inflammatory activity against acute inflammation induced by carrageenin, 5-HT and formaldehyde. While the total steroids had insignificant suppressing action on the primary phase of acute inflammation in adjuvant arthritis produced by dead tubercle bacilli, it was quite effective in suppressing the secondary lesions. These observations led us to fractionate the total steroids into its different constituents, followed by pharmacological screening, with the object of isolating the active principles.

Materials and Methods

(*a*) *Chemical.*—The petroleum ether extract of the whole plant of *V. roxburghii* was saponified with strong alkali and extracted with ether. The ether extractive (*ca.* 0·37% yield on the basis of dried drug; total steroids of Prasad *et al.*) appeared to be a mixture of at least seven compounds in varying amounts, of Rf 0·0 (*ca.* 5%), 0·32 (25%), 0·44 (20%), 0·74 (5%), 0·81 (10%), 0·91 (5%), and 1·0 (30%), as revealed by thin layer chromatography over silica gel (C_6H_6 : $CHCl_3$, 1 : 1 as solvent; I_2 vapour as developer). On repeated chromatography over Brockmann aluminium oxide the mixture could be separated into the following three single spot (TLC) compounds:

Compound A, m.p. 63–64° (micro-needles from acetone), $C_{27}H_{56}$. Analysis, uv, ir, nmr spectra, and the fragmentation pattern of the mass spectrum indicate that compound A is an aliphatic long-chain hydrocarbon (alkane), heptacosane, $C_{27}H_{56}$, containing traces of the higher homologue, $C_{29}H_{60}$.

Compound B, m.p. 80–82° (granules from acetone), $C_{28}H_{58}O$. The mass spectrum exhibits prominent higher mass peaks at m/e 448 (13·2%), 420 (43·2%), 406 (8·77%), 392 (77·7%), 378 (11·1%), 364 (48·9%), and then smaller fragment ion peaks, consistent with the fragmentation sequence $M - (18 + n\,14)$, n being 0, 1, 2, 3......etc., of long-chain alcohols. An analysis of the mass spectrum along with uv, ir, and nmr spectra, and elemental analysis indicates that compound B is an aliphatic long-chain alcohol (alkanol), octacosanol, $C_{28}H_{58}O$, containing traces of higher homologues, $C_{30}H_{62}O$ and $C_{32}H_{66}O$.

Compound C, m.p. 160–62° (needles from alcohol), Rf 0·32. It gives a violet to blue to green color reaction with Liebermann-Burchard reagent, and was identified as stigmasterol by comparison of m.p., mixed m.p. of the sterol (M^+ 412) and its acetate with those of an authentic sample. The sterol isolated from a few lots of *V. roxburghii* collected locally at different seasons was, however, characterised as β-sitosterol instead of stigmasterol.

(*b*) *Pharmacological.*—The anti-inflammatory activity of Compounds A, B and C isolated from the total steroidal fraction was studied on albino rats using the following parameters: (*i*) acute pedal inflammation induced by carrageenin 1%,[4] (*ii*) acute pedal inflammation induced by formaldehyde 1%,[5] (*iii*) croton oil induced granuloma pouch,[6] and (*iv*) cotton pellet granuloma technique.[7] The drugs were suspended in arachis oil and administered in the dose of 5 mg./100 g. I.P. In every experimental parameter one group received only the vehicle whereas another group was treated with betamethasone (25 mg./100 g. I.P.), in arachis oil for sake of comparison. Adult albino rats of either sex weighing between 100–150 g. were used for the pharmacological studies. Paw

TABLE I

Experimental parameters	Control	Compound A (10 mg./100 g. I.P.)	Compound B (10 mg./100 g. I.P.)	Betamethasone (50 mg./100 g. I.P.)
1. Carrageenin 1% induced oedema (Mean increase in paw volume ± S.E.)	11·3±0·82	6·5±0·60 $P < 0·001$	4·6 ±0·34 $P < 0·001$	2·5±0·42 $P < 0·001$
2. Formaldehyde 1% induced oedema (Mean increase in paw volume ± S.E.)	12·7±0·54	5·8±1·05 $P < 0·05$	6·0 ±0·92 $P < 0·05$	8·5±0·86 $P < 0·05$
3. Croton oil induced granuloma pouch (Mean volume of exudate in ml. ±S.E.)	0·5± 0·08	0·1±0·04 $P < 0·001$	0·08±0·01 $P < 0·001$	0·1±0·02 $P < 0·001$
4. Cotton pellet induced granuloma (Mean weight of granulation tissue in mg. ± S.E.)	160±4·7	86±9·8 $P < 0·05$	74±8·7 $P < 0·05$	42±3·8 $P < 0·001$

volume measurements were made by means of mercury plethysmograph.[8]

RESULTS

Compounds A and B were found to have significant anti-inflammatory activity. Results are summarised in Table I.

Compound C was entirely devoid of any anti-inflammatory effect against all of the experimental parameters used. The results show that Compounds A and B are active against both acute (carrageenin and formaldehyde induced oedemas) inflammation and subacute (croton oil granuloma pouch and cotton pellet granuloma techniques) inflammations. The results compare favourably with those obtained with betamethasone, though the effective dose of the latter was much lower. A comparison of the results, elicited by the two active Compounds A and B, show that their activities run parallel in equi-effective doses.

The observations are interesting for record that long-chain alkanes and alkanols, ranging from C_{27} to C_{32}, which are ubiquitous in the plant kingdom, possess anti-inflammatory activity, which has not been reported earlier.[9]

K. BASU.*
B. DASGUPTA.*
S. K. BHATTACHARYA.‡
R. LAL.‡
P. K. DAS.‡

October 26, 1970.

---

* Department of Medicinal Chemistry, Post-graduate Institute of Indian Medicine; ‡ Department of Pharmacology, College of Medical Sciences, Banaras Hindu University, Varanasi-5 (India).

1. Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glossary of Indian Medicinal Plants*, C.S.I.R., New Delhi, 1956, p. 252; Kirtikar, K. R. and Basu, B. D., *Indian Medicinal Plants*, Basu, L. M., Allahabad, 1933, **4**, 2406.
2. Das, S., Bhattacharya, (Mrs.) A. and Bhattacharya, A. K., *J. Ind. Chem. Soc.*, 1967, **44** (9), 804.
3. Prasad, D. N., Satyawati, G. V., Dasgupta, B. and Das, P. K., *Abstracts of Papers. First Congress of the South-East Asia and Pacific Area League Against Rheumatsim*, Bombay, Feb. 17–21, 1968, p. 88.
4. Winter, C. A., Risley, E. A. and Nuss, G. W., *Proc. Soc. Exp. Biol.* (N.Y.), 1962, **3**, 544.
5. Domenjoz, R., *Ann. Univ. Sarav. med.*, 1953, **1**, 317.
6. Selye, H., *J. Amer. Med. Ass.*, 1953, **152**, 1207.
7. Meier, R., Schuler, W. and Desaulles, P., *Experientia*, 1950, **6**, 49.
8. Buttle, G. A. H., D'Arcy, P. F., Howard, E. M. and Kellet, D. N., *Nature*, 1957, **179**, 629.
9. This work has been carried out under the Composite Drug Research Scheme, I.C.M.R., New Delhi. Financial assistance is thankfully acknowledged.

AN UNUSUAL MINERAL ASSEMBLAGE IN TUFFISITE VEINS AT PIMPALWANDI, DISTRICT POONA, MAHARASHTRA

MANY of the Deccan trap flows of Poona and nearby areas very often contain vein-like bodies composed of fine-grained rock of varying colour. In many cases, these bodies appear to have been formed by filling in of open joints in the lower flow from above, but at times they appear to have been intruded from below. Study of the rocks from such bodies was undertaken with a view to inquire into their nature and mode of emplacement. As a result of this study a few of such veins, exposed in well sections in the vicinity of Pimpalwandi, a village 98 km. from Poona on Poona-Nasik Road, were found to be of tuffaceous material and showed the presence of an unusual assemblage of minerals. The occurrence of the tuffisite veins and the mineral assemblage is being recorded for the first time from this part of Deccan trap region.

The veins, observed at Pimpalwandi, vary in thickness from 0·5 cm. to about 15 cm. and cut the rock in irregular manner, forming a network. They are made up of fine-grained material of earthy or pale-brown colour. Angular or subangular fragments of basalt are found incorporated in the vein material. In thin section the vein rock shows irregular fragments of varying sizes and shapes of reddish-brown glass, basalt, and grains of different minerals, sometimes showing perfect crystal forms, cemented together in a base of zeolites. The mineral assemblage comprises augite, aegirine-augite, diopside, clinoenstatite, olivine, barkevikite (?), leucite, sanidine, plagioclase felspar, epidote, chlorite and iddingsite.

Of these minerals, augite and plagioclase felspar are common constituents of Deccan basalt. Epidote, chlorite, and iddingsite could be attributed to the later deuteric activity or hydrothermal changes. The remaining minerals are found neither in the basalt, in which the veins occur, nor in the lithic fragments incorporated in them, thus indicating that the vein material was emplaced in the rock from some external source. The micro-structure of the vein rock (Fig. 1) shows its similarity with tuff. Such rocks having tuffaceous nature and occurring in the form of veins have been called 'tuffisites'.[1] Such tuffisite veins are suggested to have formed by the injection of tuffaceous material into the country rock through the medium of water[2] or gas[3] or by the mobilization of tuff due to plastic flow.[4]

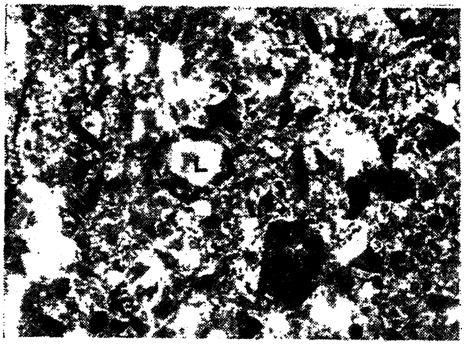


FIG. 1. Photomicrograph of tuffisite from Pimpalwandi. L – Leucite, × 15 (plane polarised light).

The presence of minerals like sanidine, aegirine-augite, leucite, and olivine suggests alkaline nature of the lava from which they were derived. The Deccan basalts are believed to be tholeitic and so far there is no record of any basalt flow of alkaline nature, containing these minerals, in this part. Their presence in the veins suggests a tuff bed or a basalt flow of alkaline nature somewhere in the vicinity.

The authors are thankful to Dr. B. G. Deshpande for providing facilities and encouragement.

Geology Dept., G. G. DESHPANDE.
University of Poona, V. V. PESHWA.
Poona, *October* 26, 1970. N. S. GHATE.

---

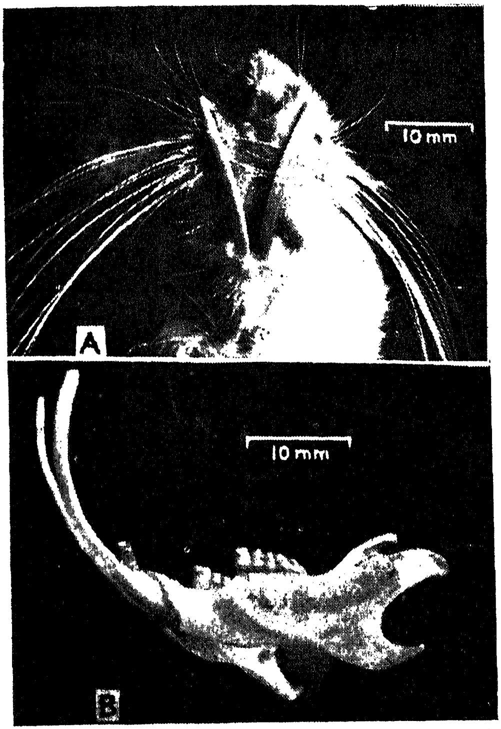
1. Whitten, E. H. T., "Tuffisites and magnetite tuffisites from Tony island, Ireland and related products of gas action," *Am. Jour. Sci.*, 1959, **257**, 113.
2. Reynolds, D. L., "The Slieve Gullion Volcano : A new interpretation of a tertiary Gabbrogranophyre complex" (discussion), *Q.J.G.S.*, 1951, **107**, Part II, p. ii-viii.
3. Colditz, Margaret, J., "Petrology of the Silurian volcanic sequence," *Jour. and Proc. of the Royal Soc. of New South Wales*, 1947, **81**, 187.
4. Greenwood, Robert, "Intrusion of mobilized tuff, Caron country, New Mexico," *Bull. G.S.A.*, 1963, **74**, 1505.

ABNORMAL DEVELOPMENT OF LOWER INCISORS IN THE INDIAN GERBIL, *TATERA INDICA INDICA* (HARDWICKE) (RODENTIA: MURIDAE)

SEVERAL instances of abnormal development of teeth in different groups of mammals have been published by Intosh (1931), Landery (1957), Chaturvedi (1966) and others. However, no case of anomaly in the dentition of any Gerbil has so far been recorded. Therefore, the following example of anomalous lower incisors in a specimen of the Indian Gerbil, *Tatera indica indica* (Hardwicke) will be of much interest on the subject.

The specimen was collected from the Punjab. It was found to be remarkable in having excessively elongated lower incisors measuring about 20 mm., which came out of the mouth and extended nearly upto forehead. The upper incisors were entirely lacking. From the structure of molar teeth and sutures of the skull it becomes obvious that the specimen was fully adult, but shorter palate and nasal length indicate that their normal development was disturbed by the overgrowth of the lower incisors. Other parts of the skull remain unaffected.

Various reasons for the abnormal development of incisors have been put forward by the earlier workers. In the present case it would appear that, probably due to some accident during the early period of its life, upper incisors failed to grow, so that the lower incisors for want of usual attrition against the upper ones, grew unabated to such an extent.



FIGS. 1, *a–b*. Fig. *a*. Head region of the specimen showing the lower incisors. Fig *b*. Lower jaw of the specimen showing the lower incisors.

Measurements (given in mm.) and taken after Ellerman, 1963).

Occipitonasal	Nasal	Palate
36·5	14	17

Zoological Survey of India,
8, Lindsay Street,
Calcutta-16,
November 5, 1970.

S. CHAKROBORTY.
D. K. GHOSAL.

---

1. Chaturvedi, Y., *Proc. Zool. Soc.*, Calcutta, 1966, **19**, 87.
2. Ellerman, J. R., *The Fauna of India*, Mammalia, (Rodentia). 1961 (1963), p. 10.
3. Intosh, W. C. M., *Trans. Roy. Soc. Edinb.*, 1931, **56**, 333.
4. Landery, S. O., *J. Mammal.*, 1957, **38**, 223.

ASSOCIATION OF SOME LEAF AND STEM CHARACTERISTICS WITH GRAIN YIELD IN PEARL MILLET

RECENTLY, there has been considerable interest in the contribution of morphological traits towards the development and formation of grains in crop plants. This aspect assumed special significance in rice, where the concept of ideal plant type changed drastically from tall-growing types having long, drooping leaves to plants with dwarf stature and short, stiff erect leaves. As with other grain crops, such concepts can be useful in pearl millet [*Pennisetum typhoides* (Burm.) S. and H.] also, and maximum yields may be achieved with varieties that have seven or eight short, stiff erect leaves per culm.[1] The present studies were carried out to determine the association of some leaf and stem characteristics with grain yield in the inbreds and hybrids of pearl millet.

The material for this study comprised 10 inbred lines of pearl millet, and 45 F_1 hybrids resulting from all possible one-way crosses among them. The inbreds and hybrids were sown in randomised block design with three replications at Ludhiana in 1969. Data were recorded on the main tiller of each plant for number of leaves, length and breadth of flag leaf and stem girth, as well as total grain yield per plant. Since the flag leaf is considered to be important with regard to its contribution towards grain dry matter production in cereal crops,[3,5] it was considered appropriate to take the measurements on length and breadth on this leaf. Correlation coefficients were worked out from the plot means (averaged over the three replications). Path-coefficient analysis, originally proposed by Wright,[6] was carried out on the lines of Dewey and Lu.[2]

The correlation coefficients among the four characters, *viz.*, number of leaves, leaf length, leaf breadth and stem girth, as well as their correlations with grain yield in the 10 inbreds and their 45 hybrids are given in Table I. In the inbred lines, all the correlations were positive, and significant at the 5% level in most cases. The only non-significant correlations

TABLE I

Correlation coefficients among various characters in the inbreds and hybrids of pearl millet

		Leaf length	Leaf breadth	Stem girth	Grain yield
Leaf number	I	0·6083	0·7335*	0·7528*	0·6559*
	H	0·6490†	0·6780†	0·5936†	0·2226
Leaf length	I	..	0·7444*	0·6801*	0·4486
	H	..	0·6574†	0·0855	0·0355
Leaf breadth	I	..	..	0·6212	0·6666*
	H	..	..	0·0625	0·4452†
Stem girth	I	..	..	..	0·7078*
	H	..	..	..	0·4724†

I = Inbreds; H = Hybrids; * Significant at 1% level; † Significant at 5% level.

were between leaf number and leaf length, leaf length and grain yield and between leaf breadth and stem girth. In the hybrids also, all the correlations were positive. However, only leaf breadth and stem girth were found to be significantly correlated with grain yield; the other two, *i.e.*, number of leaves and leaf length, were not significant.

However, to ascertain the direct and indirect effects of the four leaf and stem characteristics on grain yield in the inbreds and hybrids of pearl millet, path-coefficient analysis was undertaken (Table II). It is apparent that number of leaves and the length of leaf had negative direct effects in the hybrids. In the inbreds also, leaf length exerted a negative influence while the direct effect of the number of leaves was negligible. On the other hand, leaf breadth and stem girth appeared to influence grain yield substantially through their direct effects. Their indirect effects were also of considerable magnitude through number of leaves and leaf breadth. These characters thus appear to contribute directly as well as indirectly to grain yield in both homozygous and heterozygous populations.

TABLE II

Direct and indirect effects of some physiological traits on grain yield in the inbreds and hybrids of pearl millet

	Inbreds	Hybrids
1. Number of leaves *vs.* grain yield:		
Direct effect	0·0225	−1·3295
Indirect effect *via* leaf length	−0·2486	−0·0453
,, leaf breadth	0·4209	0·8939
,, stem girth	0·4609	0·7035
2. Leaf length *vs.* grain yield:		
Direct effect	−0·4087	−0·0699
Indirect effect *via* no. of leaves	0·0136	−0·8628
,, leaf breadth	0·4272	0·8668
,, stem girth	0·4164	0·1013
3. Leaf breadth *vs.* grain yield:		
Direct effect	0·5739	1·3185
Indirect effect *via* No. of leaves	0·0165	−0·9014
,, leaf length	−0·3042	−0·0459
,, stem girth	0·3803	0·0740
4. Stem girth *vs.* grain yield:		
Direct effect	0·6123	1·1852
Indirect effect *via* No. of leaves	0·0169	−0·7892
,, leaf length	−0·2779	−0·0060
,, leaf breadth	0·3565	0·0824

The studies indicate that varieties with thick stems and small but broader flag leaf may be more productive than those with thin stems and narrow flag leaf. Numerous long and drooping leaves will produce a self-shading effect and diminish the photo-receptive area of leaves resulting thereby in reduced photosynthetic activity. Therefore, plants with fewer, short erect leaves and thick stems may be expected to produce more yield. Although grain yield in pearl millet is generally dependent on increased single head weight and high tillering,[1] emphasis should also be laid on the leaf and stem characteristics for an efficient selection of high-yielding genotypes.

Dept. of Genetics, P. S. Phul.
Punjab Agric. University,
Ludhiana, *October* 27, 1970.

---

1. Burton, G. W. and Powell, J. B., *Adv. Agron.*, 1968 **20**, 49.
2. Dewey, R. D. and Lu, K. H., *Agron. J.*, 1959, **51**, 515.
3. Evans, L. T. and Rawson, H. M., *Aust. J. Biol. Sci.*, 1970, **23**, 245.
4. Gupta, V. P., *Indian J. Genet.*, 1968, **28 A**, 287.
5. Watson, D. J., Thorne, Gillian, N. and French, S. A. W., *Ann. Bot.* (*N.S.*), 1958, **22**, 321.
6. Wright, S., *J. Agri. Res.*, 1921, **20**, 557.

FOLIAR SPRAY OF UREA FOR YIELD INCREASE IN RICE

EFFICIENCY of applied nitrogen for rice production was suggested by Matsushima[1] to be improved by adequate supply at the neck-node differentiation stage. This is achieved by increase in the number of spikelets per panicle and less degradation of spikelets. A positive correlation between leaf nitrogen at this stage and the grain yield was found. Panicle primordia initiation stage has also been recommended by Hall and Railey[1] to be a critical stage for part nitrogen fertilization.

Field experiments were conducted at the Indian Agricultural Research Institute, New Delhi, during the *Kharif* (July-October) season of the years 1968 and 1969 on a sandy clay loam soil. The treatments comprised three dwarf varieties and a tall *indica* rice variety as the main-plot treatments and five levels of nitrogen and two methods of fertilizer application as sub-plot treatments. Application of nitrogen was split up by supplying 80% of it at transplanting (basal) and the rest at panicle initiation stage either through soil application (top-dressing) or as foliar spray of 3% urea solution in one to four applications at weekly intervals, depending upon the treatment. Each time 10 kg N per hectare was sprayed using a foot-pump sprayer adjusted to a fine nozzle.

TABLE I

Pooled average of grain yield for two years 1968 and 1969

Variety		80% basal + 20% top dressed (Nitrogen in kg/ha)				80% basal + 20% foliar (Nitrogen in kg/ha)			
		50	100	150	200	50	100	150	200
		Quintals per hectare							
IR-8	..	54·8	63·0	65·8	63·9	59·7	67·0	64·5	65·5
IR-262	..	60·1	65·0	68·3	66·8	65·1	70·2	65·9	66·1
Padma	..	54·0	59·1	63·9	60·9	56·9	63·6	59·7	60·4
NP 130	..	38·2	39·4	37·5	31·7	41·1	37·7	33·5	29·2
Level × method mean		51·8	55·6	58·8	55·8	55·7	59·6	55·9	55·3
		C.D. at 5% level							
Between any two sub plot treatment means		3·6							
Between nitrogen level × method means		1·7							

Statistical analysis of the data pooled over two years is presented in Table I.

There was a significant interaction between rates and methods of nitrogen application. For soil application, the highest yield, in general, was attained at 150 kg N/ha while the same yield was obtained by supplying only 100 kg N/ha partly through soil and partly through foliage.

Both IR-8 and IR-262 recorded the highest yield at 100 kg N/ha level of which 80 kg N was applied as basal dressing and 20 kg N as foliar spray of 3% urea solution at the panicle primordia initiation stage; the yield being 67·0 *q* and 70·2 *q* per hectare, respectively, for the two varieties. The corresponding yields at the same level, where the basal and second split doses were applied through soil, were 63·0 *q* and 65·0 *q* per hectare, respectively. The increases in yield due to foliar application were thus 4·0 *q* and 5·2 *q* per hectare, respectively, over the soil application method and these differences were statistically significant. For Padma, the increase in yield at 100 kg N/ha, due to foliar method of application, was 4·5 *q* per hectare more than the soil application method.

The data also revealed that part foliar application was effective in increasing yield only at the lower rates of nitrogen. At higher rates, the yield due to part foliar application was either at par or slightly less than the application of the fertilizer all through soil.

It is thus seen that foliar method of nitrogen application at panicle primordia initiation stage of rice crop increased the productive efficiency of the applied fertilizer. Such a method of fertilization may reduce the high fertilizer requirement of the high-yielding dwarf *indica* rice. This method of application enables attainment of the maximum yield potential of the variety at a considerably lower fertilizer dose and can thus lead to a saving of 40 to 50 kg of nitrogen per hectare, of that required for soil application.

Division of Agronomy, U. P. BHASKARAN
Indian Agric Res Inst., RAJAT DE
New Delhi-12, *October* 23, 1970.

---

1. Hall, V. L. and Railey, R. M., "Timing nitrogen fertilization of rice with the morphological development of the plant," *Rice J.*, 1964, **67** (12), 6.
2. Matsushima, S., *Nitrogen Requirement at Different Stages of Growth," The Mineral Nutrition of Rice Plant*, IRRI, Oxford and IBH Publishing Co. Calcutta, 1961, p. 210.

SOME NEW RECORDS OF RICE HOPPERS IN MAHARASHTRA

WITH the introduction of high yielding varieties of paddy and change in cultivation practices, several problems have arisen which demand attention and investigation. Leaf and plant hoppers, which were hitherto considered as a pest of minor importance in the State of Maharashtra, have now become serious pests. In addition to their direct damage, they may pose a threat as carriers of virus diseases.

Khare (1965) surveyed the drilled and transplanted paddy areas of Poona and Kolaba Districts of the State and reported eight species of rice leaf hoppers. During the course of this investigation, field as well as light trap sampling was carried out since the year 1966, and six new hoppers were recorded for the first time in the State.

A brief account of the hoppers is furnished in Table I.

TABLE I

List of rice hoppers in Maharashtra

Sl. No.	Species	Family	Period	Intensity	Host	Type of viruses
	(I) LEAF HOPPERS					
1	**Nephotettix apicalis*, Mots. ..	Deltocephalidae	Aug.-Sept.	Severe	Wheat, ragi and citrus	Rice dwarf
2	**Nephotettix impecticeps*, Ish. ..	do.	do.	do.	do.	Rice yellow dwarf, Tungro and yellow stunt
3	*Inazuma dorsalis*, Mots. ..	do.	August	Mild	..	Orange leaf and rice dwarf
4	**Typhlocyba maculifrons*, Mots.	do.	Sporadic	do.	Wheat	
5	**Kolla mimica*, Dist. ..	Tettigellidae	do.	Less	do.	
6	**Cicadulina bipunctella*, Mots. ..	Deltocephalidae	do.	do.	do.	
7	**Balclutha hebe*, Kirk, ..	do.	do.	do.	Wheat and jowar	
8	**Cicadulina mbila*, Naude. ..	do.	do.	do.	Wheat and maize	
9	**Typhlocyba jaina*, Dist. ..	do.	do.	do.	do.	
10	*Thaia subrufa*, Melich. ..	do.	do.	do.	do.	
11	*Scaphoideus morosus*, Melich. ..	do.	do.	do.	do.	
	(II) PLANT HOPPERS					
12	**Tettigonella spectra*, Dist. ..	Delphacidae	Aug.-Sept.	Mild	..	Grassy stunt
13	*Nilaparvata lugens*, Stal. ..	do.	Sept.-Oct.	Severe	..	
14	*Sogotella furcifera*, Hor. ..	do.	do.	do.	..	

Note:— (i) Viruses mentioned are not so far reported in the State. (ii) Species Nos. 4 to 9 were observed in drilled paddy areas. (iii) * Reported by Khaire in 1965.

Thanks are due to the Director of Commonwealth Institute of Entomology, London, for identifying the hoppers.

Rice Research Station,
Mahatma Phule Krishi Vidyapeeth,
Karjat (Kolaba), *October* 23, 1970.

V. M. KHAIRE.
D. G. BHAPKAR.

1. Khaire, V. M., "Studies on jassid fauna of Central Maharashtra," *Thesis* submitted to the University of Poona for partial fulfilment of M.Sc. (Agril.) Degree in Agricultural Entomology, 1965 (Unpublished).

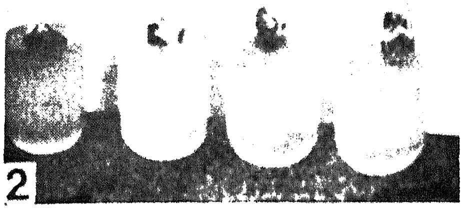
DIFFERENTIATION OF *SACCHARUM OFFICINARUM* TISSUES *IN VITRO**

THE cultivation of monocot tissues has been rarely successful. However, Carter *et al.* (1967) report the cultivation of *Avena sativa* tissues on a purely synthetic medium and Yatazawa *et al.* (1967) the induction of callus tissue from rice roots by the addition of yeast extract, 2, 4-dichlorophenoxyacetic acid (2, 4-D). In an attempt to cultivate the tissues of *Saccharum officinarum* Linn., the observations on their differentiation are reported.

Sugarcane was obtained from Bogadhi village near Manasa Gangothri campus, University of Mysore, and stem segments of the 2nd and 3rd internodes from the apex were grown on modified White's medium (Miller and Skoog, 1953) supplemented with 2% sucrose and 1% Difco agar and adjusted to pH 5·5. Iron was supplied in the form of "sodium-ferric-ethylene-diaminotetraacetate". One cm. long internodal cylinders sterilized in chlorine water were cut into four segments and planted on 40 ml. of the basal medium in pyrex flasks or test-tubes. For each treatment, five replications were used. The cultures were stored at 22° to 24° C. under diffused daylight conditions in the laboratory.

When the internodal segments were planted on the basal medium supplemented with 0·5 to 5 mg./l. of kinetin and 0·1 to 5 mg./l. of naphthaleacetic acid (NAA) very little callus appeared on the segment in 20 days. The medium became dark possibly due to the exudation of polyphenols. However, when the segments were placed on a medium with 2, 4-D (0·1, 1, 5 mg./l.) and kinetin (0·5 and 5 mg./l.) the callus was seen on the eleventh day and after four weeks the callus on the stem segments produced green nodular structures. When the segments were transferred to a fresh medium (0·1 mg./l. 2, 4-D and 0·5 mg./l. kinetin) buds differentiated from the nodules after two weeks (Figs. 1 and 2). When these buds were planted in the soil they developed into healthy sugarcane plants. Their growth and development were kept track up to a height of 8" to 12".

ncorporation of [illegible] coconut [illegible] into the [illegible] lium with 2,4-D [illegible] 5 mg./l. [illegible] effected [illegible]



GS. 1–2. Fig. 1. [illegible] 60 days after plating [illegible] supplemented with 2,4-D [illegible] mg./l. [illegible] 2. Nodular [illegible] into green [illegible] 0·1 mg./l. [illegible] the left two [illegible] 4-D and [illegible]

nent [illegible] e the growth [illegible] nced [illegible] olysate [illegible] rowth [illegible]

[illegible] of Agri[illegible] [illegible]
al Campus,
galore-24, and
ernment College, [illegible]
ura

---

his work was carried [illegible] at the [illegible] rtment of [illegible], Mana[illegible] Gangothri [illegible] University, ysore, Mysore.

Carter, [illegible], [illegible] 1967, **214**, 1029.

Miller, C. [illegible] and [illegible], *Amer.* [illegible], 1953, **40**, 768.

Yatazawa, M., [illegible], [illegible] and [illegible], M., *Plant Cell Physiol.*, 1967, **8**, 363.

MORPHACTIN AND CYTOKININS INTERACTION IN SEEDLING GROWTH OF *RUELLIA TUBEROSA* LINN.

[illegible] in all phases of plant growth. The[illegible] broad range of effect on [illegible] morphological behaviour of [illegible] in several varie[illegible] established [illegible] An apparent [illegible] and kinetin [illegible] the growth [illegible] growth [illegible] the antagonism [illegible] *R. tuberosa* [illegible]

[illegible] *R. tuberosa* were germinated [illegible] filter paper [illegible] equal [illegible] were 6 [illegible] done in 10 [illegible] The roots [illegible] statistically interpreted in Table I.

[illegible] of various concentrations of dif[illegible] on seedling growth of *R. tube*[illegible] [illegible] ppm. [illegible] acceleration of growth at the end [illegible] and 36·9[illegible] and SD 8339, [illegible] radicle and hypocotyl [illegible] the concentration was raised [illegible] marked inhibition of radicle and [illegible] hypocotyl was observed.

When [illegible] with 2ip the SD 8339 [illegible] similar growth [illegible] promoted seedling growth at a faster rate in [illegible] ppm. concentrations than [illegible] kine[illegible] or SD 8339.

Results relating to interaction of morphactin with cytokinins on seedling growth of

TABLE I

List of rice hoppers in Maharashtra

Sl. No.	Species	Family	Period	Intensity	Host	Type of viruses
	(I) LEAF HOPPERS					
1	**Nephotettix apicalis*, Mots. ..	Deltocephalidae	Aug.-Sept.	Severe	Wheat, ragi and citrus	Rice dwarf
2	**Nephotettix impicticeps*, Ish. ..	do.	do.	do.	do.	Rice yellow dwarf, Tungro and yellow stunt
3	*Inazuma dorsalis*, Mots. ..	do.	August	Mild	..	Orange leaf and rice dwarf
4	**Typhlocyba maculifrons*, Mots.	do.	Sporadic	do.	Wheat	
5	**Kolla mimica*, Dist. ..	Tettigellidae	do.	Less	do.	
6	**Cicadulina bipunctella*, Mots. ..	Deltocephalidae	do.	do.	do.	
7	**Balclutha hebe*, Kirk, ..	do.	do.	do.	Wheat and jowar	
8	**Cicadulina mbila*, Naude. ..	do.	do.	do.	Wheat and maize	
9	**Typhlocyba jaina*, Dist. ..	do.	do.	do.	do.	
10	*Thaia subrufa*, Melich. ..	do.	do.	do.	do.	
11	*Scaphoideus morosus*, Melich. ..	do.	do.	do.	do.	
	(II) PLANT HOPPERS					
12	**Tettigonella spectra*, Dist. ..	Delphacidae	Aug.-Sept.	Mild	..	Grassy stunt
13	*Nilaparvata lugens*, Stal. ..	do.	Sept.-Oct.	Severe	..	
14	*Sogotella furcifera*, Hor. ..	do.	do.	do.	..	

Note:— (i) Viruses mentioned are not so far reported in the State. (ii) Species Nos. 4 to 9 were observed in drilled paddy areas. (iii) * Reported by Khaire in 1965.

Thanks are due to the Director of Commonwealth Institute of Entomology, London, for identifying the hoppers.

Rice Research Station,
Mahatma Phule Krishi
Vidyapeeth,
Karjat (Kolaba), *October* 23, 1970.

V. M. KHAIRE.
D. G. BHAPKAR.

---

1. Khaire, V. M., "Studies on jassid fauna of Central Maharashtra," *Thesis* submitted to the University of Poona for partial fulfilment of M.Sc. (Agril.) Degree in Agricultural Entomology, 1965 (Unpublished).

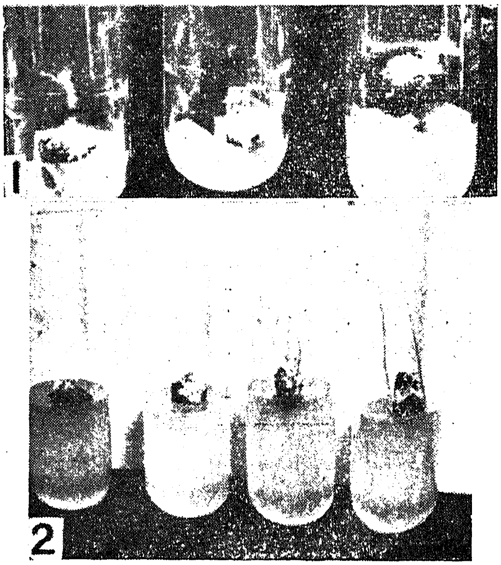
DIFFERENTIATION OF *SACCHARUM OFFICINARUM* TISSUES *IN VITRO**

THE cultivation of monocot tissues has been rarely successful. However, Carter *et al*. (1967) report the cultivation of *Avena sativa* tissues on a purely synthetic medium and Yatazawa *et al.* (1967) the induction of callus tissue from rice roots by the addition of yeast extract, 2, 4-dichlorophenoxyacetic acid (2, 4-D). In an attempt to cultivate the tissues of *Saccharum officinarum* Linn., the observations on their differentiation are reported.

Sugarcane was obtained from Bogadhi village near Manasa Gangothri campus, University of Mysore, and stem segments of the 2nd and 3rd internodes from the apex were grown on modified White's medium (Miller and Skoog, 1953) supplemented with 2% sucrose and 1% Difco agar and adjusted to pH 5·5. Iron was supplied in the form of "sodium-ferric-ethylene-diaminotetraacetate". One cm. long internodal cylinders sterilized in chlorine water were cut into four segments and planted on 40 ml. of the basal medium in pyrex flasks or test-tubes. For each treatment, five replications were used. The cultures were stored at 22° to 24° C. under diffused daylight conditions in the laboratory.

When the internodal segments were planted on the basal medium supplemented with 0·5 to 5 mg./l. of kinetin and 0·1 to 5 mg./l. of naphthaleacetic acid (NAA) very little callus appeared on the segment in 20 days. The medium became dark possibly due to the exudation of polyphenols. However, when the segments were placed on a medium with 2, 4-D (0·1, 1, 5 mg./l.) and kinetin (0·5 and 5 mg./l.) the callus was seen on the eleventh day and after four weeks the callus on the stem segments produced green nodular structures. When the segments were transferred to a fresh medium (0·1 mg./l. 2, 4-D and 0·5 mg./l. kinetin) buds differentiated from the nodules after two weeks (Figs. 1 and 2). When these buds were planted in the soil they developed into healthy sugarcane plants. Their growth and development were kept track up to a height of 8″ to 12″.

Incorporation of 10% coconut milk into the medium with 2, 4-D (0·1 mg./l.) and kinetin (0·5 mg./l.) elicited more callus on the stem segments and of 40% produced roots. Addition of yeast extract (5, 25, 50 mg./l.) did not improve the growth of the callus. However, it produced roots on the callus at 50 mg./l. Casein hydrolysate was not superior to yeast extract in growth promotion.



FIGS. 1-2. Fig. 1. Stem segments of *Saccharum officinarum* 60 days after planting on modified White's medium supplemented with 2, 4-D (0·1 mg./l.) and Kinetin (0·5 mg./l.). Note the bud formation in the 2nd tube. Fig. 2. Nodular structures on the stem segments developing into green shoots on medium supplemented with 2, 4-D (0·1 mg./l.) and Kinetin (0·5 mg./l.) (right two tubes), the left two tubes contain 5 : 5 and 0·1 : 0·5 mg./l. of 2, 4-D and Kinetin respectively.

Univ. of Agri. Sciences, R. NARAYANA.
Hebbal Campus,
Bangalore-24 ; and
Government College, H. SRINIVASAN.
Mercara.

---

* This work was carried out at the Post-Graduate Department of Botany, Manasa Gangothri, University of Mysore, Mysore.

1. Carter, O., Yamada, Y. and Takahashi, E., *Nature*, 1967, **214**, 1029.
2. Miller, C. O. and Skoog, F., *Amer. J. Bot.*, 1953, **40**, 768.
3. Yatazawa, M., Furahashi, K. and Shimzu, M., *Plant Cell Physiol.*, 1967, **8**, 363.

MORPHACTIN AND CYTOKININS INTERACTION IN SEEDLING GROWTH OF *RUELLIA TUBEROSA* LINN.

MORPHACTINS (derivatives of fluorene-9-carboxylic acid) in some form are probably implicated in all phases of plant growth. These compounds have a broad range of effect on physiological and morphological behaviour of plants.[3] Promotion of seed germination and seedling growth by cytokinins in several varieties of lettuce has definitely been established.[2,6] It has been reported that 6-benzylaminopurine, SD 8339, kinetin and 6-(γ, γ-dimethylallylamino) purine induces flowering to varying degrees in *Lemna paucicostata*.[1] An apparent antagonism between morphactin and kinetin during the lettuce seed germination has also been observed.[4] Because of the growth inhibiting action of morphactins and their reversal by cytokinins in seedling growth, the present study was undertaken to study the antagonism in the process of seedling growth in quick germinating seeds of *R. tuberosa*.[5]

The seeds of *R. tuberosa* were germinated (34° ± 2° C. and 1,000 lux light intensity) in 12 cm. petri-dishes containing a single layer of Whatman No. 1 filter-paper moistened with 10 ml. of distilled water (control) or an equal amount of test solutions or their mixtures. The cytokinins used for these experiments were 6-furfurylaminopurine or kinetin ; 6-benzylamino-9-(tetrahydropyran-2-yl)-9 H purine or SD 8339, and 6-(γ, γ-dimethylallylamino) purine or 2 ip. All the measurements were done in 10 days after setting the experiments. The mean average lengths (in mm.) of radicle and hypocotyl have been statistically interpreted in Table I.

The effects of various concentrations of different cytokinins on seedling growth of *R. tuberosa* clearly indicate an extreme sensitivity and even as low a concentration as 10^{-2} ppm showed a marked acceleration of growth at the end of the tenth day (kinetin, 37·5% and 36·9% ; 2 ip, 46·9% and 52·3% and SD 8339, 35·0% and 36·9% promotion in radicle and hypocotyl respectively). If the concentration was raised to 10^{-1} ppm a marked inhibition of radicle and lesser of hypocotyl was observed.

When compared with 2 ip, the SD 8339 and kinetin indicated a similar growth in 10^{-1} ppm. The 2 ip promoted seedling growth at a faster rate in 10^{-2} ppm concentrations than did kinetin or SD 8339.

Results relating to interaction of morphactin with cytokinins on seedling growth of

Table I

The effect of morphactin and cytokinins alone and in combination on the seedling growth of R. tuberosa. *All measurements are in mm.*

Chemicals		Conc. in ppm	Radicle	Hypocotyl	Percentage promotion (+) or inhibition (−)	
					Radicle	Hypocotyl
Control	..	..	32·0±9·7	13·0±2·2	..	..
Kinetin	..	10^{-1}	34·0±5·9	17·0±4·2	+ 6·2	+30·7
,,	..	10^{-2}	44·8±3·8	17·8±2·1	+37·5	+36·9
2 ip	..	10^{-1}	34·4±2·2	19·4±2·3	+ 7·5	+49·2
,,	..	10^{-2}	47·0±6·8	19 8±2·7	+46·9	+52·3
SD 8339	..	10^{-1}	33·8±3·5	16·4±2·0	+ 5·6	+26·1
,,	..	10^{-2}	43·2±3·5	17·8±2·1	+35·0	+36·9
Morphactin	..	5	11·0±2·8	10·6±3·8	−65·1	−18·4
Morphactin+Kinetin	..	$5+10^{-1}$	11·8±1·7	19·5±1·0	−63·1	+50·0
,,	..	$5+10^{-2}$	17·2±1·5	17·0±2·3	−46·2	+30·7
Morphactin+2 ip	..	$5+10^{-1}$	16·2±4·4	19·8±2·5	−49·3	+52·3
,,	..	$5+10^{-2}$	18·7±1·6	18·3±1·9	−41·5	+40·7
Morphactin+SD 8339	..	$5+10^{-1}$	13·0±3·1	18·4±3·4	−59·3	+41·5
,,	..	$5+10^{-2}$	18·2±1·5	19·6±2·7	−40·2	+52·3

R. tuberosa were extremely interesting. It is clear from Table I that whereas morphactin considerably inhibited the seedling growth, the cytokinins acted as strong antagonists. A comparison of these results indicated that 2 ip is far superior to SD 8339 and kinetin in reversing the morphactin induced inhibition of seedling growth.

The authors thank E. Merck, Darmstadt, for the generous gift of morphactin (IT 3456), Professor N. J. Leonard, U.S.A., for 2 ip, Professor K. Yokoyama, U.S.A., for kinetin, and Dr. R. W. A. Leach, U.K., for SD 8339.

Botany Dept.,
Univ. of Jodhpur,
Jodhpur (Raj.),
India, October 8, 1970.

D. D. Chawan.
D. N. Sen.
K. D. Sharma.

1. Gupta, S. and Maheshwari, S. C., *Plant and Cell Physiol.*, 1969, **10**, **231**.
2. Miller, C. O., *Ann. Rev. Pl. Physiol.*, 1967, **18**, 349.
3. Mohr, G., *Dtsch. Bot. Ges. Neue Folge.*, 1969, **3**, 5.
4. Sankhla, N. and Sankhla D., *Planta*, 1967, **76**, **47**.
5. Sen, D. N, and Chatterji, U. N., *Osterr. Bot. Zeit.*, 1966, **113**, **390**
6. Skinner, C. G., Claybook, J. R., Tolbert, F. and Shire, W., *Plant Physiol.*, 1957, **32**, 117.

REVIEWS AND NOTICES OF BOOKS

Global Geophysics. By R. H. Tucker, A. H. Cook, H. M. Iyer and F. D. Stacey. (The English Universities Press Ltd., St. Paul's House, Warwick Lane, London, E.C. 4), 1970. Pp. 199. Price £ 2 25 d.

World observations obtained during the International Geophysical Year, and recent techniques of using artificial satellites for collecting geophysical data have given an impetus to the study of geophysics in schools and colleges and there is a need for an introductory book with a fresh outlook which will provide a broad understanding of the subject without too much of mathematics. The book under review which considers the solid earth as a whole, just meets this need.

The four authors have each contributed a section dealing with that aspect of geophysics in which he is an active worker. Thus, Mr. Tucker gives an introductory background of the Earth as a solar planet and discusses its spin and orbital motions. Professor Cook has written the section on geodesy and considers the earth's shape and gravitational field. Dr. Iyer deals with seismology and surveys the crustal elastic waves ranging from microseisms, through nuclear seismology, to devastating earthquakes. Finally, Dr. Stacey writes on geomagnetism and deals with palaeomagnetism, magnetosphere, and radiation belts.

A. S. G.

The Role of Nitrogen in Grassland Productivity. By D. C. Whitehead. (Commonwealth Agricultural Bureaux, Farnham House, Farnham Royal, Slough, SL 2, 3 BN, England), 1970. Pp. viii + 202. Price £2·25 ; $ 5.90.

This publication is Bulletin 48 of the Commonwealth Bureau of Pastures and Field Crops and it gives a review of the results of investigations on the subject carried out in temperate regions.

The key role that nitrogen plays in the agricultural production from grassland is well recognized and it has been the subject of much research all over the world. Grassland productivity increases with the supply of fertilizer N, but the magnitude of the increase depends on a number of factors, some susceptible to management control and others not. Studies of the nitrogen relations of grassland have occupied an important place in the research programme of the Grassland Research Institute, Hurley, and a considerable amount of data has been built up over the past 15 years. The author, Dr. Whitehead of this Institute, gives an up-to-date review of the information available on the subject (confined to temperate regions) which will be useful not only to research workers but also to those giving advice on practical aspects of grassland management.

The subject-matter is covered in three main sections of the book. Part I deals with nitrogen transformations in grassland ecosystems ; Part II with the yield response of grass swards to the application of fertilizer N as influenced by environmental and management factors, and Part III discusses the effect of fertilizer N on the composition and quality of herbage. The bibliography contains 516 references to literature on the subject. A. S. G.

Productivity of Terrestrial Animals—Principles and Methods. By K. Petrusewicz and A. Macfadyen. (Blackwell Scientific Publications, 5, Alfred Street, Oxford, OX 1, 4 HB, England), 1970. Pp. xii + 190. Price 50 *sh.*

Under the aegis of the International Biological Programme (IBP), a working meeting on Principles and Methods of Secondary Productivity of Terrestrial Ecosystems was held at Jablonna from 30th August to 6th September 1966, at the invitation of the Polish Academy of Sciences. It was attended by 66 members from 14 countries and 54 papers were read.

A purpose of the technical meetings of the IBP has been to advise on methods of research, the aim being not so much of standardization but to give workers in different parts of the world a means whereby their results will be comparable with results by other workers in other areas. Accordingly, after the Jablonna meeting, the authors were invited to collaborate in producing a handbook on the subject to aid researchers.

The outcome of this effort is the present publication which forms the IBP Handbook No. 13. Needless to say that this manual will be welcomed by practising ecologists who are engaged in implementing the objectives of the IBP in this particular field of the secondary productivity of terrestrial ecosystems.

A. S. G.

Annual Review of Astronomy and Astrophysics (Vol. 8). Editor : Leo Goldberg. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California, U.S.A.), 1970. Pp. ix + 495. Price : U.S.A. : $ 10.00 ; Foreign : $ 10.50.

The current volume of this well-known *Annual Review of Astronomy and Astrophysics* contains 14 topics of which nearly half the number represent new fields that have developed within the past 5 to 10 years and reviewed in this series for the first time. Thus, Prof. A. Hewish's article on *Pulsars* gives the results so far obtained on these galactic radiopulsating objects first discovered by himself and coworkers only three years ago in 1967. A closely related field concerns *Neutron Stars* and the article by A. G. W. Cameron reviews new information on the subject since 1966. In the chapter on *Astronomical Fourier Spectroscopy*, Pierre Connes discusses the application to astronomical problems of a technique developed first for laboratory use.

The article on "Radiofrequency Recombination Lines", by A. K. Dupree and Leo Goldberg deals with spectral lines in the radiofrequency domain emitted as a result of transitions between atomic levels with high principal quantum numbers. "Optical Observations of Extrasolar X-ray Sources", by W. A. Hiltner and D. E. Mook reviews those sources in X-ray astronomy for which there are well-established optical counterparts, for example, Sco X-1 and Cyg X-2.

The question of rotation in the deep solar interior is a controversial subject of considerable importance to relativity theory as well as to solar physics. R. H. Dicke in the article on "Internal Rotation of the Sun" discusses the present state of knowledge on the subject.

M. S. Vardya reviews recent studies on the "Atmospheres of Very Late-Type Stars", especially those of the M, S and C, spectral types; while I. J. Danziger surveys in the chapter, "The Cosmic Abundance of Helium", the observational and theoretical results that may help to elucidate this as yet unsuccessful problem.

The other articles in the volume are: "The Origin of Solar Magnetic Fields", by E. N. Parker; "The Theory of Stellar Winds and Related Flows", by T. E. Holzer and W. I. Axford; Information-Processing Systems in Radio Astronomy and Astronomy", by B. G. Clark; "Excitation and Ionization by Electron Impact", by Oleg Bely and Henri Van Regemorter.

In the last and perhaps the longest article in this volume, Prof. G. R. Burbidge reviews the observational evidence concerning "The Nuclei of Galaxies". He also discusses in detail the possible origin and evolution of galactic nuclei and the ways in which their activity bears on general galactic evolution and on cosmological problems.

Lastly, a special mention is to be made of the article on "Auroral Physics", by Sir Sydney Chapman, the outstanding geophysicist of the century, whose death took place in June last year. Perhaps this is one of Professor Chapman's last published articles. Auroral physics has been one of the pet subjects of Professor Chapman and in this short but authoritative review article he traces the history of auroral observations, the auroral spectrum, the auroral morphology and the auroral particles.

A. S. G.

ERRATA

Curr. Sci., Vol. 40, No. 3, Feb. 5, 1971: P. 60, Note on "Neutron Diffraction Study of Triglycine Sulfate", II col., para (*i*) last sentence should read: ......So the two glycine ions are monoprotonated and the third is a ......*et al.*

P. 66, Note on "A New Laboratory Technique for Preservation of Plant Specimens": Read *Styrofoam* for *Polystyrene* in lines 1 and 3 of para 2, and in line 3 of para 3.

Books Received

Mathematics—A Modern Introduction. By M. L. Keedy and M. L. Bittinger. (Addison-Wesley Pub. Co., Inc., West End House, 11, Hills Place, London W. 1, England), 1970. Pp. 462. Price 85 *sh.*

Progress in Analytical Chemistry (Vol. 3): *X-Ray and Electron Probe Alalysis in Biomedical Research.* Edited by K. M. Earle and A. J. Tousimis. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011, U.S.A.), 1970. Pp. ix + 105. Price $12.50.

An Introduction to Metabolic Pathways. By S. Dagley and D. E. Nicholson. (Blackwell Scientific Publications, 5, Alfred Street, Oxford OXI-4, 4 HB, England), 1970. Pp. xi + 343. Price 75 *sh.*

Industrial Chemistry (Part II)—*Inorganic and Organic.* By R. K. Das. (Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1), 1969. Pp. xiii + 403. Price Rs. 18.

Introduction to Differential Geometry. By Abraham Goetz. (Addison-Wesley Pub., Co., West End House, 11, Hills Place, London W. 1, England), 1970. Pp. x + 350. Price 112 *sh.*

Algebra and Its Applications—A Problem-Solving Approach. By C. W. Sloyer. (Addison-Wesley Pub. Co., Inc., West End House, 11, Hills Place, London W. 1, England), 1970. Pp. 189. Price 70 *sh.*

Particles Sources and Fields. By J. Schwinger. (Addison-Wesley Pub. Co., Inc., West End House, 11, Hills Place, London W. 1, England), 1970. Pp. ix + 425. Price 140 *sh.*

The NMR of Polymers. By I. Ya. Slonim and A. N. Lyubimov. (Plenum Publishing Corporation, 227, West 17th Street, New York, N.Y. 10011), 1970. Pp. x + 365. Price $19.50.

The Megatectonics of Continents and Oceans. Edited by Helgi Johnson and Bennett L. Smith. (Rutgers University Press, 30, College Avenue, New Brunswick, N.J. 08903), 1970. Pp. xii + 282. Price $12.50.

Molecules and Life—An Introduction to Molecular Biology. By M. V. Vol'kenshtein. Translated from Russian by S. N. Timasheff. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xiii + 513. Price $15.00.

2550-71. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.

CITRIC ACID METABOLISM IN THE FRUIT TISSUES OF *CITRUS ACIDA*[*]

C. V. RAMAKRISHNAN

Department of Biochemistry, Baroda University, Baroda

CITRUS fruits are grown in tropical and sub-tropical regions throughout the world and rank probably third among the sub-tropical fruits of the world.

The origin of citric acid and other constituents present in the fruits has been a subject of great interest. The main question is whether they are formed in the fruit tissue itself or whether they are formed in the leaf and transferred to the fruit. In the former case, the question also arises regarding the mechanisms involved in their formation and accumulation in fruit tissue. The latter belief is referred to as the translocation hypothesis.

The translocation hypothesis received the support of Nitsch[1] according to whom the acids are translocated from the leaves to the fruits which merely act as storage organs. Earlier Gatet[2] and Ballard, Magness and Hawkins[3] found that the acidity in grapes and apples was higher at the centre than at the periphery of the fruit and that a reduction in leaf area decreased the acid content of the fruit. But the results must be considered equivocal as obviously such reduction would affect the supply of carbohydrate necessary for cellular synthesis and would affect organic acid content whether it is formed locally from carbohydrate or supplied by the leaves. Similarly, regional differences in the concentration of enzymes could well account for the greater concentration of organic acid at the centre.

The alternate hypothesis that the presence of organic acids in fruits is due to conversion of carbohydrate into organic acids in the fruit vesicles and not due to translocation seems more plausible in the light of recent studies.

As early as 1933, Riccvuto[4] suggested the formation in lemons of citric acid from reducing sugar and pentosans by enzymic action. In their studies on valencia oranges, Sinclair and Eny[5] found the distribution of citric, malic and oxalic acids in leaves, juice and peel to vary considerably. The highest concentration of total, malic and oxalic acids was found in leaves, whereas the juice contained the highest concentration of citric acid, and the peel the lowest concentration of citric acid as well as total acids. These findings led them to suggest that the organic acids are synthesized in the vesicles from carbohydrates.

This hypothesis received substantial support from the ingenious studies carried out by Erickson[6] who grafted a sweet lemon on a sour lemon plant and a sour lemon on a sweet lemon plant. Analyses of the fruits showed that the acidity of sweet lemons remained low (0·44%) and that of sour lemons remained high (5·2%) irrespective of the leaves by which they were nourished. The sweet lemon also had a much higher reducing sugar concentration (5·17%) than the sour lemon (1·45%). These findings certainly did not support the translocation hypothesis and point to local synthesis. This suggestion has been amply supported by enzyme studies which show that the fruit tissue possesses the enzyme machinery necessary for the synthesis of citric acid in the case of lemon[7] and garcinia.[8]

Nada[9] who analysed fruits of *Vitis vinifera* at different stages of development for sucrose and total acid observed an increase in acidity and a decrease in sucrose and polysaccharides during the initial stages of growth and the reverse phenomenon during the later stages. A similar observation was made by Deshpande and Ramakrishnan[8] in fruits of garcinia (*Xanthochymus guttiferae*). Studies carried out by Ramakrishnan and Varma[7] showed an association between increase in citric acid content and decrease in carbohydrate during the development of the lemon fruit (*Citrus acida*). These authors also found that the sugar and protein contents and total acidity of young and old leaves and of stems bearing young fruits and mature fruits do not differ when considered in terms of percentage dry weight. On the other hand, substantial differences are found between young and mature fruits in the case of which the sugar and protein contents decrease with growth whereas the acidity increases. Similarly, the pattern of organic acids is the same in young and old leaves and stems bearing young and mature fruits. Citric, malic, succinic, fumaric and oxalic acids are present in both categories of leaves and stems. But in the case of fruits the pattern of organic acids

---

[*] Studies reported in this review are partly supported by Am PL 480 grant FG–In–258.

varies with development. Young fruits are found to contain only malic, fumaric and oxalic acids. When the fruits attain a size of 1·5 cm diameter citric acid begins to accumulate, fumaric acid disappears, and oxalic acid is still present in small amounts. As they reach maturity, citric acid is the major constituent, malic acid being present in small amounts.

Reports on the feasibility of cultivating the lemon fruit *in vitro* in a nutrient medium containing mineral salts and sucrose[10-17] and the demonstration of starch synthesis *in vitro* in lemon fruit[18] indicate the independence of fruit tissues as a metabolic entity capable of synthesizing its own cellular constituents.

It is found that both the lemon and the garcinia fruit contain the enzymes necessary for the formation of citric acid from glucose[7,19] and that the mature fruit is characterised by a high activity of citrate synthase and the disappearance of aconitase.[7,8]

The evidence cited above seems to have been ignored by Lioret and Moyse[20] who favour the hypothesis of translocation. They report the absence of citrate synthase in fruits accumulating citric acid. This is surprising since the enzyme has been found in lemon[7] and garcinia.[8] It is possible that the enzyme preparation in their experiments was inactivated due to a sudden release of excess acid during the preparation of the homogenate.

Recent studies suggest that even the carbohydrate necessary for organic acid synthesis may be derived from the outer skin of the fruit which is shown to have photosynthetic capacity. Bean and Todd[12] while studying the $C^{14}O_2$ uptake by young oranges with and without exposure to light found that the sugars are highly labelled in the photosynthesizing flavedo. Sucrose is found to be labelled to an appreciable extent in the albedo of the intact fruit exposed to sunlight but only to a limited extent if the same is isolated and exposed to light. This suggested that the major activity in the albedo of the intact photosynthesizing fruit is due to translocation from the flavedo. A very slight amount of activity is found in illuminated, isolated vesicles. However, they accumulate a large amount of citric acid during light deprivation although the peel has a low concentration of the same.

A number of factors indicate that products such as citric acid formed during light deprivation must be formed within each tissue rather than by extensive translocation from one tissue to another. In the intact fruit photosynthesis results in an increase in the incorporation of labelled $C^{14}O_2$ and a redistribution in flavedo but has no effect on the vesicles. The changes in the albedo, however, appear to be restricted to carbohydrate components.

Recent studies carried out in this laboratory on carbohydrate metabolism in different areas of the citrus fruit show that the green skin is an active site for the photosynthesis of carbohydrate whereas the vesicle is the main site of citric acid formation followed by the septa. The white skin seems to be rather a relatively inert site of carbohydrate metabolism and its major function could be translocation of glucose from the green skin to the interior of the fruit. The juice seems to represent merely the spill-over products from the tissues. The vesicles and green skin are also found to be very active sites for the conversion of glucose to ascorbic acid.[22]

These studies show that even different parts of the fruit are independent to a considerable extent.

The above studies show that carbohydrates are utilized for the formation of citric acid in the fruit tissues due to the operation of glycolytic pathway and the tricarboxylic acid cycle and citric acid accumulates in the mature fruit due to absence of aconitase. It is found that while the young fruit tissue in which no citric acid accumulates is able to effect the oxidation of all the intermediates of the tricarboxylic acid cycle the mature fruit tissue in which citric acid accumulates is able to oxidise all other TCA cycle intermediates except citric acid. This raises the question regarding the mode of respiration of the mature fruit tissue.

The accumulation of citric acid due to absence of aconitase raises the question regarding the operation of respiratory mechanisms in the mature fruit. The breakdown of protein and the utilization of amino-acids for respiration suggests itself as a possibility on the basis of studies carried out during starvation,[23] senescence[23] and water stress.[24]

Several techniques have been used for inducing starvation in plants by restricting or preventing photosynthesis. These include light deprivation, water deprivation and CO_2 deprivation.

Studies have been made of the effects of light deprivation on nitrogen metabolism in etiolated seedlings.[25-27] Barley seeds were allowed to germinate in the dark and determinations made on different days of the respiratory rate and the contents of carbohydrate and nitrogen both in the endosperm and embryo. During the first six days of germination the reserves of the embryo, namely, sucrose, raffinose and small amount of fat were rapidly broken down. The respiratory quotient during this time was maintained at a value close to unity indicating that carbohydrates furnished most of the respiratory substrate. Thereafter the stores were found to be exhausted and the respiratory quotient began to fall to a value of about 0·8 suggesting that non-carbohydrate sources, presumably proteins, were used for respiration. Similarly, tobacco leaves detached from the plant and immersed for 72 hours in water showed an initial depletion of starch. Subsequently, a breakdown of protein was evident. After 70 hours hexose and sucrose along with free amino-acids especially glutamic acid and aspartic acid were used for respiration.[28]

Studies carried out by Thompson *et al.*[24] on the effect of water stress in turnip leaves showed that protein content decreases at a rapid rate in the wilted leaves and this is associated with a rise in ammonia suggesting that deamination of amino-acids provides oxidisable substrates for respiration.

In the case of fruits such as apples and bananas, ripening is accompanied by a sharp rise in respiration and this rise is associated with a net initial protein synthesis followed by a steady fall in protein content and an increase in amino nitrogen and asparagine.[29] These studies suggest that protein is utilized for respiration during ripening. Studies were therefore carried out in this laboratory to find out whether a similar phenomenon occurs in the mature fruit tissues of *Citrus acida*. Respiratory studies carried out on tissue slices of young and old fruits showed that the R.Q. was unity in the former case whereas it was 0·8 in the latter case suggesting that non-carbohydrate sources, presumably proteins, are used for respiration in the latter case (Sakariah and Ramakrishnan, unpublished data). In other studies a decrease in protein nitrogen associated with increases in amino and amide nitrogen as well as glutamic acid and asparagine was found in the mature fruit.[30] In studies on respiration using different amino-acids as substrates glutamic acid was found to be used for respiration by the mature fruit tissue but not by the young tissue. While the addition of glutamate had no effect on oxygen uptake in the young fruits it increased the same by 50% in the mature fruit. Addition of glutamic acid resulted in the increased formation of ammonia but this was prevented by the simultaneous addition of aspartic acid which resulted in an increase in asparagine.[30] The specific activities of enzymes concerned with glutamate utilization were high in the mature fruit.[30] The results of these studies suggest that the mode of respiration in the mature fruit is by the conversion of glutamate to 2-oxoglutarate which gets further oxidised by the Krebs cycle. The ammonia formed appears to be removed and detoxified by the formation of asparagine.

In conclusion, studies carried over the last several years in this laboratory and elsewhere suggest that the citrus fruit tissue is metabolic entity in its own right capable of synthesizing many of its major constituents. The fruits of *Citrus acida* possess the metabolic machinery for photosynthesis as well as the operation of the glycolytic and TCA cycles. A block in the operation of the TCA cycle in the mature fruit at citrate level would account for the accumulation of citrate in the mature fruit. A failure in respiration as a result of this block is apparently prevented by the utilization for respiration of glutamate derived from the breakdown of proteins. The accumulation of ammonia during the deamination of glutamate appears to be prevented by its incorporation into aspartate to form asparagine. The different parts of the fruit tissue seem to have quite distinct metabolic characteristics and differ with regard to their photosynthetic capacity and organic acid metabolism.

---

1. Nitsch, J.P., *Ann. Rev. Plant Physiol.*, 1953, **4**, 199.
2. Gatet, L., *Ann. Physiol. Physicochem. Biol.*, 1939, **15**, 984; *cf.* Nitsch, J. P., *Ann. Rev. Plant Physiol.*, 1953, **4**, **199**.
3. Ballard, W. S., Magness, J. R. and Hawkins, L. A., *U.S. Dept. Agri. Bull.*, 1922, **24**, 1104; *cf.* Nitsch, J. P., *Ann. Rev. Plant Physiol.*, 1953, **4**, **199**.
4. Ricevuto, A., *Ann. Chim. Applicate*, **1933**, **23**, **411**.
5. Sinclair, W. B. and Eny, D. M., *Plant Physiol.* 1947, **22**, 257.
6. Erickson, L. C., *Science*, 1957, **125**, 994.
7. Ramakrishnan, C. V. and Varma, T. N. S., *Memoirs*, *Indian Bot. Soc.*, 1959, **2**, 79.
8. Deshpande, W. M. and Ramakrishnan, C. V., *J. Biol. Chem.*, 1961, **236**, **2377**.
9. Nada, J. A. A., *Bull. Fac. Agr. Cairo Univ. No.* 52, p. 14; *cf. Chem. Abs.*, 1958, **52**, **17415**.
10. Schroeder, C. A., *California Agriculture*, 1960, **14**, 10.
11. —, *Bot. Gaz.*, 1961, **122**, 198.
12. Kordan, H. A., *Bull. Torrey Bot. Cl.*, 1962, **89**, 49.
13. —, *Ibid.*, 1963, **90**, 293.
14. —, *Ibid.*, 1963, **90**, 308.
15. —, *Nature*, 1963, **198**, 867.
16. —, *Bull. Torrey Bot. Cl.*, 1964, **91**, 271.
17. —, *Ibid.*, 1965, **92**, 209.
18. —, *Ibid.*, 1965, **92**, 21.

19. Parekh, L. J., Sakariah, K. K. and Shah, V. J., *Enzymologia*, 1970, 38, 29.
20. Lioret, C. and Moyse. A., *cf. Comparative Biochemistry*, Edited by Florkin, M. and Mason, H. S., Academic Press, New York, 1963, **5**, 203.
21. Bean, R. C. and Todd, G. W., *Plant Physiol.*, 1960, **35**, 425.
22. Parekh, L. J. and Shah V. J., *Enzymologia* (In press).
23. Steward, F. C. and Street, H. E., *Ann. Rev. Biochem.*, 1947, **16**, 471.
24. Thompson, J. F., Steward, C. R. and Morries, C. J., *Plant Physiol.*, 1966, **41**, 1578.
25. Barnell, H. R., *Proc. Roy. Soc.*, 1937, **B 123**, **312**.
26. James, W. O. and James, A. L., *New Phytologist*, 1940, **39**, **145**.
27. Forward, D. F., *Ibid.*, 1951, **50**, 297.
28. Ranjan, S. and Laloraya, M. M., *Plant Physiol.*, 1965, **40**, 235.
29. Hulme, A. C., *Biochem. J.*, 1948, **43**, 343.
30. Ramakrishnan, C. V., Parekh, L. J. and Sakariah, K. K., *Enzymologia* (In press).

A NEW CLASS OF ELECTROMAGNETIC FIELDS

R. M. MISRA AND DEO BHUSHAN PANDEY

Department of Physics, University of Gorakhpur, Gorakhpur, India

RECENTLY, several authors[1-4] have derived theorems which may be used to generate electromagnetic solutions of the field equations from given vacuum solutions. These results are generalisations of an earlier work by Weyl[5] who investigated axially symmetric gravitational fields. Such electromagnetic fields are, therefore, known as Weyl class of electromagnetic fields. In this note we discuss a procedure by which one can generate a new class of electromagnetic fields, which are not of Weyl type, from a given axially symmetric, vacuum gravitational field.

Consider the following set of field equations:

$$R_{ij}-(1/2)\,g_{ij}\,R\equiv G_{ij}=-\,8\pi E_{ij}, \qquad (1)$$

$$F^{ij}{}_{;j}=0, \qquad (2)$$

$$F_{[ij;k]}=0, \qquad (3)$$

where

$$E_{ij}=(1/4\pi)\,[g^{kl}F_{ik}F_{jl}-(1/4)\,g_{ij}F_{kl}F^{kl}]. \qquad (4)$$

The symbols used here have their usual meaning. We choose the axially symmetric static metric in the form[6]

$$ds^2=e^{2u}\,dt^2-e^{2k-2u}\,[(dx^1)^2+(dx^2)^2]-h^2\,e^{-2u}\,d\phi^2, \qquad (5)$$

where u, k and h are functions of x^1 and x^2 only. The vacuum field equations for the metric (5) are easily obtained as:

$$u_{,11}+u_{,22}+(1/h)\,(u_{,1}h_{,1}+u_{,2}h_{,2})=0, \qquad (6)$$

$$2\,(u_{,2}^{\,2}-u_{,1}^{\,2})+(2/h)\,(k_{,1}h_{,1}-k_{,2}h_{,2})+(1/h)\,(h_{,22}-h_{,11})=0, \qquad (7)$$

$$2u_{,1}u_{,2}-(1/h)\,(k_{,2}h_{,1}+k_{,1}h_{,2})+\frac{h_{,12}}{h}=0, \qquad (8)$$

$$h_{,11}+h_{,22}=0. \qquad (9)$$

However, if one takes the stress-tensor of an electromagnetic field as the source of the gravitational field equations, *i.e.*, Eqn. (1), one can obtain the field equations with the help of only two components of the four potential. If one introduces the potentials A and B in the following manner[3,7,8]

$$\left.\begin{array}{l}F^{\alpha\beta}=(-\,g)^{-1/2}\,\epsilon^{\alpha\beta\gamma}A_{,\gamma}\\ F_{0\alpha}=B_{,\alpha}\end{array}\right\},\quad \alpha,\beta\ldots=(1,2,3) \qquad (10$$

where $A=A(x^1,x^2)$ and $B=B(x^1,x^2)$, one obtains the stress-tensor E_{ij} in a symmetrical form with respect to A and B. Further, there are only two non-trivial Maxwell equations amongst (2) and (3) which are identical with regard to A and B. This situation allows one to introduce a single potential C such that:

$$\left.\begin{array}{l}A=C\sin\alpha\\ B=C\cos\alpha\end{array}\right\}, \qquad (11$$

where α is a constant. Equations (11) are equivalent to a 'duality rotation' of Misner and Wheeler.[9] These considerations lead to the following field equations:

$$u_{,11}+u_{,22}+(1/h)\,(u_{,1}h_{,1}+u_{,2}h_{,2})=-\,e^{-2u}\,[C_{,1}^{\,2}+C_{,2}^{\,2}], \qquad (12$$

$$u_{,2}^{\,2}-u_{,1}^{\,2}+(1/h)\,(k_{,1}h_{,1}-k_{,2}h_{,2})+(1/2h)\,(h_{,22}-h_{,11})=e^{-2u}\,[C_{,1}^{\,2}-C_{,2}^{\,2}], \qquad (13$$

$$2u_{,1}u_{,2}-(1/h)\,(k_{,2}h_{,1}+k_{,1}h_{,2})+(h_{,12}/h=-\,2e^{-2u}\,C_{,1}C_{,2}. \qquad (14$$

Further, the only non-vanishing Maxwell equation is obtained as:

$$C_{,11}+C_{,22}+(1/h)\,(C_{,1}h_{,1}+C_{,2}h_{,2})-2\,(C_{,1}u_{,1}+C_{,2}u_{,2})=0. \qquad (15$$

Let us now introduce an auxiliary function M defined in terms of u by the relation:

$$e^u = \lambda h \sinh \mathrm{M} \qquad (16)$$

where $\mathrm{M} = \mathrm{M}(x^1, x^2)$ and λ is an arbitrary constant. When expressed in terms of M Eqns. (12) and (15) become:

$$\cosh \mathrm{M} \sinh \mathrm{M} \,[\mathrm{M}_{,11} + \mathrm{M}_{,22} + (1/h) \times (h_{,1}\mathrm{M}_{,1} + h_{,2}\mathrm{M}_2)] - (\mathrm{M}_{,1}{}^2 + \mathrm{M}_{,2}{}^2) = -(1/\lambda^2 h^2)(\mathrm{C}_{,1}{}^2 + \mathrm{C}_{,2}{}^2), \qquad (17)$$

$$\mathrm{C}_{,11} + \mathrm{C}_{,22} - (1/h)(h_{,1}\mathrm{C}_{,1} + h_{,2}\mathrm{C}_{,2}) = 2 \coth \mathrm{M}\,(\mathrm{C}_{,1}\mathrm{M}_{,1} + \mathrm{C}_{,2}\mathrm{M}_{,2}) \qquad (18)$$

One may easily see by direct substitution that Eqn. (18) is identically satisfied if we choose the following relation between M and C.

$$\mathrm{C}_{,1} = -\lambda h \mathrm{M}_{,2}, \quad \mathrm{C}_{,2} = \lambda h \mathrm{M}_{,1} \qquad (19)$$

Further, Eqn. (17) in view of (19) becomes,

$$\mathrm{M}_{,11} + \mathrm{M}_{,22} + (1/h)(\mathrm{M}_{,1}h_{,1} + \mathrm{M}_{,2}h_{,2}) = 0. \qquad (20)$$

which is same as Eqn. (6) with u replaced by M. It may be noted that the integrability condition for C, *i.e.*, $\mathrm{C}_{,12} = \mathrm{C}_{,21}$ also leads to Eqn. (20).

Now, Eqns. (13) and (14), when expressed in terms of M become, in view of (19):

$$2(\mathrm{M}_{,2}{}^2 - \mathrm{M}_{,1}{}^2) + (2h_{,1}/h) \times [k_{,1} - \{\log (h \sinh^2 \mathrm{M})\}_{,1}] - (2h_{,2}/h)[k_{,2} - \{\log (h \sinh^2 \mathrm{M})\}_{,2}] + (1/h)(h_{,22} - h_{,11}) = 0, \qquad (21)$$

$$2\mathrm{M}_{,1}\mathrm{M}_{,2} - (h_{,1}/h) \times [k_{,1} - \{\log (h \sinh^2 \mathrm{M})\}_{,1}] - (h_{,2}/h)[k_{,2} - \{\log (h \sinh^2 \mathrm{M})\}_{,2}] + h_{,12}/h = 0. \qquad (22)$$

We can therefore write:

$$k = \bar{k} + \log (h \sinh^3 \mathrm{M})$$

where $\bar{k}$ is determined from:

$$2(\mathrm{M}_{,2}{}^2 - \mathrm{M}_{,1}{}^2) + (2/h)(\bar{k}_{,1}h_{,1} - \bar{k}_{,2}h_{,2}) + (1/h)(h_{,22} - h_{,11}) = 0, \qquad (23)$$

$$2\mathrm{M}_{,1}\mathrm{M}_{,2} - (1/h)(\bar{k}_{,1}h_{,2} + \bar{k}_{,2}h_{,1}) + h_{,12}/h = 0. \qquad (24)$$

One may notice that Eqns. (23) and (24) are the same equations as (7) and (8) with k replaced by $\bar{k}$. Thus, we have established the following theorem:

"For every static vacuum gravitational field with axial symmetry there corresponds a solution of the combined Maxwell-Einstein equations of the type discussed in this note which do not belong to Weyl class of electromagnetic solutions."

A special case of the investigations presented in this note was discussed earlier by Gautreau and Hoffman.[10]

---

1. Misra, M. and Radhakrishna, L., *Proc. Nat. Inst. Sc., India*, 1962, **28 A**, 632.
2. Harrison, B. K., *Phys. Rev.*, 1965, **138B**, 488.
3. —, *J. Math. Phys.*, 1968, **9**, 1744
4. Misra, R. M., *Phys. Rev.*, 1970, **D 2**, 2125.
5. Weyl, H., *Ann. Physik*, 1917, **54**, 117.
6. Janis, A. I., Newman, E. T. and Winicour, J., *Phys. Rev.*, 1968, **176**, 1507.
7. Tauber. G., *Can. J. Phys.*, 1957, **35**, 477.
8. Misra. R. M. and Deo Bhushan Pandey, *Commun. Math. Phys.*, 1971, **20**, 324.
9. Misner, C. W. and Wheeler, J. A., *Ann. Phys.*, 1957, **2**, 525.
10. Gautreau, R. and Hoffman, R. B., *Phys. Rev.*, 1970, **2 D**, 271.

K-X RAY AND GAMMA-RAY ANGULAR CORRELATIONS IN THE DECAY OF ^{153}GD AND ^{186}RE, USING HIGH EFFICIENCY SUM-PEAK COINCIDENCE SCINTILLATION SPECTROMETER

K. VENKATA RAMANA RAO AND V. LAKSHMINARAYANA
Laboratories for Nuclear Research, Andhra University, Waltair

THERE has been a considerable interest in recent years on the angular correlations between X-rays emitted by isotopes in K-capture decay and the following gamma-rays. Dolginov[1] proposed a theory which denies any such correlation. However, Perepelkin[2] reported a finite correlation with a ^{54}Mn source in contradiction with the theory. Subsequent studies of Ramaswamy,[3,4] and Fechner *et al.*[5] did not find evidence for any such correlation. Since sum-coincidence techniques are very sensitive for the detection of small anisotropies, a systematic investigation is undertaken on K-X ray and gamma-ray directional correlations. Earlier studies[6] with an ^{114m}In source did not show any anisotropy. The studies are extended to include different nuclear environments and different types of K-capture.

Radioactive sources ^{153}Gd and ^{186}Re used in the present work are obtained as liquids from the Isotopes Division of Bhabha Atomic Research Centre, Bombay. The details of the sum-peak coincidence set-up used in the present study are already published.[7] The set-up is arranged in a 7 cm sum-peak coincidence mode and the sum-peak coincidence spectra are recorded for angles 90°, 135°, 180°, 225° and 270° between the detectors, for 10 minutes at each angle. The sum-peak coincidence spectra recorded in each case are shown in Fig. 1. and Fig. 2.

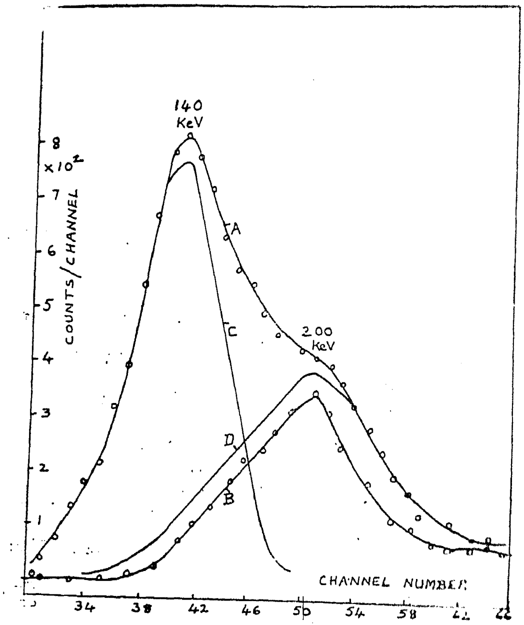


FIG. 1. Sum-Peak Coincidence Spectra Decay of ^{153}Gd. 7 cm. geometry. A – Zero-bias spectrum. B – 70 keV bias spectrum. C – Zero-bias spectrum – normalised. D – 70 keV bias spectrum – normalised.

The spectrum shown in Fig. 1 with ^{153}Gd source has two peaks—one around 140 keV and the other is a bump around 200 keV. The peak at 140 keV corresponds to the summing of the K-X ray with the gamma transitions 70, 97 and 103 keV, while the bump on the high energy side is due to the chance summings of these transitions. The 70 keV bias sum-peak coincidence spectrum shown in Fig. (1-B) contains only one peak around 200 keV supporting this identification. Normalised distribution representing the 70 keV bias spectrum (represented by spectrum 1-D) is subtracted from the zero-bias spectrum to represent the K-X ray and gamma-ray summing (*vide* spectrum 1-C). Spectrum [illegible] tion work in the case [illegible]

Figure 2 [illegible] representing the K-X [illegible] gamma-ray summing [illegible] representing [illegible] 137 keV gamma [illegible] of ^{186}Re [illegible] coincidence spectra [illegible] this identification. [illegible] employed for angular [illegible]

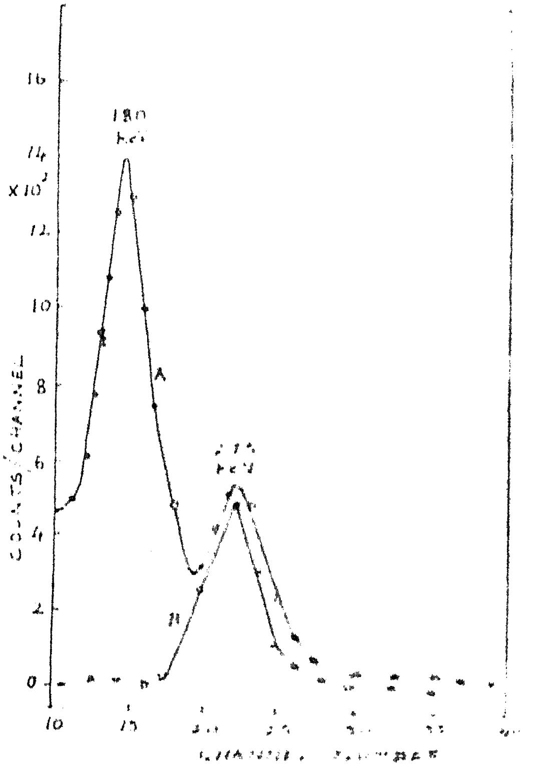


FIG. 2. Sum-Peak Coincidence Spectra [illegible] 7 cm. geometry. A – Zero bias spectrum. [illegible] 100 keV bias spectrum.

The corrected true coincidence rate [illegible] in a standard polynomial of the type

W (θ) [illegible] 1 + A_2P_2 cos θ + A_4P_4 [illegible]

and the correlation coefficients [illegible] tained in both cases are given in Table I

TABLE I

Corrected final values of the angular correlation coefficients

S. No.	Isotope	Sum-peak	$A_2 \times 10^2$	$A_4 \times 10^2$
1	^{153}Gd	140 keV	+(0·648 ±0·726)	[illegible]0·87[illegible] ± 0·88[illegible])
2	^{186}Re	180 keV	+(1·04 ±1·36)	[illegible]1·0[illegible] ± 2·32

It can be seen from Table I that in none of the cases the value of the correlation coefficient exceeded the corresponding experimental error indicating the failure for the detection of finite anisotropy in the K-X ray and gamma-ray angular correlations. These results support Dolginov's theory. The K-capture in the case of ^{186}Re is of the first forbidden type ($1^- \rightarrow 2^+$), while the K-capture groups are mixed in the case of the K-capture decay of ^{153}Gd. Two of these are of the allowed type $(3/2)^+ \rightarrow (3/2)^+$ and $(3/2)^+ \rightarrow (5/2)^+$ and the other is of the first forbidden type [$3/2)^+$ $(5/2)^-$]. Absence of finite correlation in both cases indicates the essential absence of anisotropy in the gamma-ray distribution.

The magnetic environments of the decay products ^{153}Eu and ^{186}W are different in as much as in the former case the valence electron configuration is $(6s)^2$, $(4f)^7$, while the corresponding configuration for ^{186}W is $(6s)^2$, $(4f)^{14}$, $(5d)^4$. The magnetic fields are essentially due to incompletely filled *f* shell electrons in the case of ^{153}Eu and incompetely filled *d* shell electrons in case of ^{186}W. The absence of any difference in angular correlations in both cases shows the essential absence of the K-X ray and gamma-ray angular correlations.

One of the authors (Venkata Ramana Rao) is thankful to the Council of Scientific and Industrial Research, Government of India, New Delhi, for providing him with a Senior Research Fellowship. He is also grateful to Dr. D. L. Sastry for his keen interest and useful discussions in this work.

---

1. Dolginov, A. Z., JETP, *Soviet Phys.*, 1958, **7**, 644.
2. Perepelkin, V. V., JETP Letters, *Ibid.*, 1967, **5**, 81.
3. Mc Donnel, M. and Ramaswamy, M. K., *Phys. Rev.*, 1968, **171**, 1278.
4. Ramaswamy, M. K., *Physics Letters*, 1968, **27 B**, 215.
5. Fechner, J., *et al.*, *Ibid.*, 1968, **26 B**, 374.
6. Murthy, D. S., Ramana Rao, K. V., Jagam, P., and Lakshminarayana, V., *Canad. J. Phys.*, 1970, **48**, 1514.
7. (*a*) Lakshminarayana, V., Invited Talk, *Proceedings of the Nuclear Physics and Solid State Physics Symposium*, of Department of Atomic Energy, Government of India, Dec. 1968, **1**, 107. (*b*) Venkata Ramana Rao, K., *Ph.D. Thesis*, Andhra University, Waltair. 1970.

FIRST ASIAN CONGRESS OF NUTRITION

THE First Asian Congress of Nutrition was held at Hyderabad (India) between 28th January and 2nd February 1971. The Congress was sponsored by the Nutrition Society of India and the Indian National Science Academy under the auspices of the International Union of Nutritional Sciences. Dr. C. Gopalan, Director of the National Institute of Nutrition, Hyderabad, was the President of the Congress and Mr. A. H. Boerma, Director-General, F.A.O., Rome, delivered the key-note address. The Congress was attended by over 500 delegates representing 21 countries.

The main theme of the Congress was "Nutrition and National Development". The subjects discussed at the ten symposia covered a wide range of topics of common interest. Besides the symposia, 18 special reports and over 100 research communications were presented.

At the concluding session of the six-day Congress, it was decided to hold such a Congress once in three years. A steering committee was constituted for the purpose and Dr. C. Gopalan was unanimously elected as Chairman of the Steering Committee. It was also decided to set up a permanent machinery to develop collaborative research programmes on problems of malnutrition common to the Asian region.

LETTERS TO THE EDITOR

THE GENERAL LORENTZ MATRIX AND SOME IDENTITIES

The general Lorentz transformation connecting two inertial frames $S(o\text{-}xyzt)$ and $S'(o'\text{-}x'y'z't')$ and involving six arbitrary parameters of relative velocity and relative orientation may be expressed in the form

$$\begin{aligned} x' &= \left[l_1 + \frac{Lu_1(\gamma-1)}{u^2}\right]x + \left[m_1 + \frac{Mu_1(\gamma-1)}{u^2}\right]y + \left[n_1 + \frac{Nu_1(\gamma-1)}{u^2)}\right]z - \frac{\gamma u_1}{c}\,.\,ct \\ y' &= \left[l_2 + \frac{Lu_2(\gamma-1)}{u^2}\right]x + \left[m_2 + \frac{Mu_2(\gamma-1)}{u^2}\right]y + \left[n_2 + \frac{Nu_2(\gamma-1)}{u^2}\right]z - \frac{\gamma u_2}{c}\,.\,ct \\ z' &= \left[l_3 + \frac{Lu_3(\gamma-1)}{u^2}\right]x + \left[m_3 + \frac{Mu_3(\gamma-1)}{u^2}\right]y + \left[n_3 + \frac{Nu_3(\gamma-1)}{u^2}\right]z - \frac{\gamma u_3}{c}\,.\,ct \end{aligned} \tag{1}$$

$$ct' = -\frac{L\gamma}{c}x - \frac{M\gamma}{c}y - \frac{N\gamma}{c} + \gamma\,.\,ct,$$

where the velocity of S' relative to S is (u_1, u_2, u_3) in the co-ordinates f S' and (L, M, N) in the co-ordinates of S. Thus

$$\left.\begin{aligned} &u_1 l_1 + u_2 l_2 + u_3 l_3 = L, \text{ etc.} \\ &L l_1 + M m_1 + N n_1 = u_1, \text{ etc.} \\ &L^2 + M^2 + N^2 = u_1^2 + u_2^2 + u_3^2 = u^2 \end{aligned}\right\} \tag{2}$$

and

$\gamma = (1 - u^2/c^2)^{-\frac{1}{2}}$ and l_1, m_1, n_1, etc., are direction cosines. The transformation is proper and orthochronous, since $\det(g_{ij}) = 1$ and $g_{44} \equiv \gamma \geqslant 1$ for the matrix g_{ij} of the transformation.

One can verify for this transformation that

$$(g_{12} - g_{21})(g_{34} - g_{43}) + (g_{23} - g_{32})(g_{14} - g_{41}) (+ g_{31} - g_{13})(g_{24} - g_{42}) = 0. \tag{3}$$

This may be expressed as

$$\epsilon^{ijkl} g_{ij} g_{k2} = 0 \tag{4}$$

in the usual notation. It is also equivalent to

$$\det(g_{ij} - g_{ji}) = 0, \tag{5}$$

In the usual notation the defining property of the Lorentz matrix is

$$g^T \eta g = \eta \tag{6}$$

and since η^2 is the unit matrix,

$$g \eta g^T = \eta, \tag{7}$$

(6) and (7) may be written as equivalent sets of ten algebraic conditions on g_{ij}. It should be possible to prove (3) from (6). K. B. Prabhu Patkar has recently shown that (3) follows from (6) and in the process obtained three distinct identities of the form

$$g_{ij}g_{kl} - g_{il}g_{kj} + g_{ji}g_{lk} - g_{li}g_{jk} = 0. \qquad i \neq j \neq k \neq l \tag{8}$$

(3) is a consequence of (8).

Even in the general case when the diagonal matrix η has diagonal elements ± 1 so that g_{ij} as defined by (3) is not necessarily a Lorentz matrix, (8) holds good and (3) follows from it. This has been checked by P. P. Kale.

University of Poona, V. V. Narlikar.
Poona, *December* 31, 1970.

STUDY OF ULTRASONIC ABSORPTION AROUND THE CRITICAL REGION IN *n*-HEXANE-O-TOLUIDINE

The study of absorption of ultrasonic waves in mixtures has shown that the classical viscothermal contributions are inadequate to explain the anomalously large absorption around the critical region.[1-3] Fixman[4,5] has proposed a theory for the excess sound absorption and dispersion in these systems based on the effect of temperature fluctuations caused by the sound wave on the local properties near the critical region.

For binary systems Fixman's theory of sound absorption can be expressed as follows:

$$\frac{\alpha}{f^2} = A\, f^{-5/4} g[f(d)] + B(T) \tag{1}$$

where

$$d = C f^{-1/2}\, |T - T_c| \tag{2}$$

where α is the linear absorption coefficient, f the frequency T_c the critical temperature, A, B(T), C are constants and $g[f(d)]$ is the imaginary portion of a definite integral $f(d)$ known numerically[6] analytically.

This paper presents the results of absorption around the critical region of the binary system *n*-hexane-O-toluidine. Fixman's theory is applied to these results.

This system has a critical composition of 0·52 mole fraction of O-toluidine and a critical solution temperature of 21·2° C. The ultrasonic absorption and velocity have been studied over the entire composition range at 22° C, 27° C and 32° C in the frequency range of 3 to 9MHz using standard pulse technique. The liquid sample is maintained to within $\pm 0{\cdot}1°$ C by means of an ultrathermostat type NBE. The absorption measurements are correct to ± 5% around the critical region and 10% in other regions.

At any particular concentration the velocity was found to decrease with increasing temperature as is normal in the case of liquids. The variation of α/f^2 with concentration of O-toluidine for the four frequencies and at each temperature is shown in Fig. 1. It can be seen from Fig. 1 that there is an absorption maximum at 0·52 mole fraction of O-toluidine for all frequencies and temperatures. For each temperature there is a regular decrease in α/f^2 with increasing frequency at any particular concentration around the critical composition. The peak values of α/f^2 fall rapidly as the temperature shifts away from the critical solution temperature.

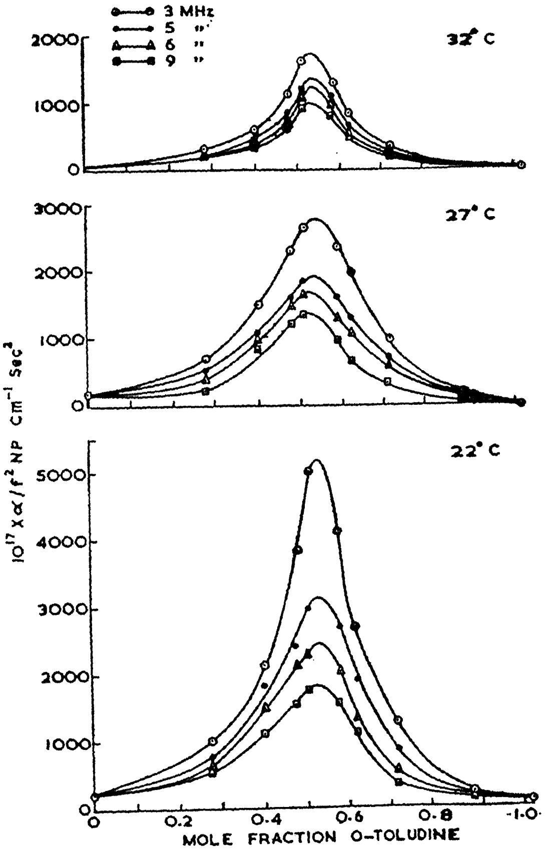


FIG. 1

The values of A and C have been computed by fitting the experimental data at the critical composition at 9MHz at all temperatures in equations (1) and (2), they are equal to $1{\cdot}137 \times 10^{-5}$ Np cm^{-1} sec$^{-3/4}$ and $0{\cdot}155$ sec$^{-1/2}$ deg^{-1} respectively. Using these values of A and C theoretical values of absorption have been computed and compared with experimental data in Fig. 2. The agreement is fairly satisfactory and shows that α/f^2 is proportional to $f^{-5/4}$. Th may be taken as an indication that Fixmar theory can satisfactorily explain the anomalo absorption around the critical region.

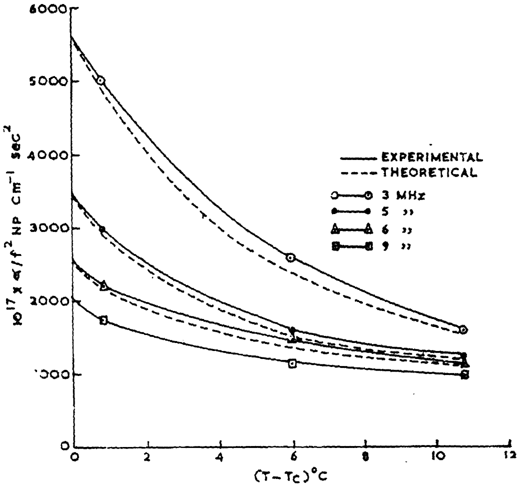


FIG. 2

The authors are grateful to Prof. B. R. R for his encouragement and the Council Scientific and Industrial Research for financial assistance.

Dept. of Physics, P. C. Raj
Andhra University, K. Subbar
Waltair (A.P.), *October* 21, 1970.

---

1. Chynoweth, A. G. and Schneider, W. G., *J. C Phys.*, 1957, **19**, 1566.
2. Kruus, P., *Can. J. Chem.*, 1964, **42**, 1712.
3. Anantharaman, A. V., Walters, A. B., Edm P. D. and Pings, C. J., *J. Chem. Phys.*, 196 2651.
4. Fixman, M., *J. Chem. Phys.*, 1962, **36**, 1957, 1
5. —, *Ibid.*, 1965, **42**, 196, 199.
6. Kendig, A. P., Bigelow, H. R., Edmonds, P. Pings, C. J., *Ibid.*, 1964, **40**, 1451.

REACTION OF CADMIUM ACETYLACETONATE WITH NITROGEN DONOR LIGANDS

DIVALENT zinc ($3d^{10}$) and divalent cadmium ($4d^{10}$) have completely filled d-shells and hence usually form four-coordinated tetrahedral compounds utilising $4s4p^3$ and $5s5p^3$ hybrid orbitals respectively for bonding. If experimental conditions are favourable, the co-ordination number can increase to five or six involving one or two higher d-orbitals. We reported[1,2] earlier some penta- and hexa-coordinated complexes of zinc (II). In this communication, we report cadmium (II) complexes containing acetylacetonate and substituted pyridine or quinoline as ligands.

To an ethanolic suspension of $Cd(OH)_2$, a mixed solution of acetylacetone (2 ml.) and nitrogen donor ligand (0·5 ml.) was added and warmed. The resulting clear solution on cooling overnight gave a shining white crystalline compound in each case. Alternatively, the same compounds were also obtained when cadmium acetylacetonate (0·5 g.) was dissolved in a mixed solution of acetylacetone (2 ml.) and nitrogen donor ligand (1 ml.), warmed and cooled. The separated compounds were filtered, washed with petroleum ether and dried *in vacuo*. The melting point, analytical and molecular weight data of the complexes are given in Table I.

TABLE I

M.P., analyses and molecular weight of mixed ligand complexes of cadmium (II)

Compound	M.P. (°C.)	Molecular weight		% Cadmium	
		Reqd.	Found	Reqd.	Found
Cd (acac)$_2$	225	310·4	..	36·2	36·0
Cd (acac)$_2$·4-mepy	200	403·5	440	27·8	27·6
Cd (acac)$_2$·4-vpy	185	415·5	Insol.	27·0	26·8
Cd (acac)$_2$·(quin)$_2$	180 *d*	568·4	562	19·7	19·7
Cd (acac)$_2$·2-mequin	155 *d*	453·4	406	24·7	24·3

We had earlier tried to prepare some penta-coordinated anionic complexes of cadmium (II) by reacting tetrahalo cadmium (II) complexes with thiourea. Instead, we could isolate and report[3] only more common four-coordinated $[CdCl_3.tu]^-$ complexes. Similar studies on mixed ligand complexes of zinc (II), however, gave rise to penta-coordinated compounds.[1,2] Divalent cadmium ion should also increase its co-ordination number under favourable conditions. Corbridge and Cox[4] reported penta-co-ordinated dichloro terpyridyl cadmium (II) and also zinc (II). Further, more recently Higgins and Saville[5] reported that piperidine gives 1 : 1 complex with cadmium diethyldithiocarbamate wherein the cadmium ion is penta-coordinated.

Amongst the complexes now reported, those having the formula $Cd(acac)_2L$ where L is 4-methyl pyridine, 4-vinyl pyridine and 2-methyl quinoline are penta-coordinated and $Cd(acac)_2(quin)_2$ is hexa-coordinated. These complexes have low melting points and are fairly soluble in organic solvents. They are monomeric in freezing benzene. These compounds are entirely different from the starting material $Cd(acac)_2$ and one mole (or two moles) of reacting *liquid* ligand has definitely been bonded to the metal. This is also revealed by the infra-red spectra (not given here) which contain the characteristic absorption bands of both aceylacetone and the reacting ligand and there are no bands due to co-ordicated water indicating its absence. Hence, it is clear that the compounds having the formula $Cd(acac)_2L$ now reported are penta-coordinated and are analogous to similar penta-coordinated compounds of zinc (II) reported by Graddon and Weeden.[6]

Our thanks are due to the Ministry of Education, Government of India, New Delhi, for granting a Research Training Scholarship to one of us (B. P.).

Dept. of Chemistry, B. PAUL.
Regional Engg. College, D. V. RAMANA RAO.
Rourkela-8, *November* 2, 1970.

---

1. Guru, S. and Ramana Rao, D. V., *Curr. Sci.* 1967, **36**, 317.
2. — and —, *Z. Anorg. Chem.*, **1968**, **358**, 187.
3. Paul, B. and Ramana Rao, D. V., *Canadian J Chem.*, 1968, **46** (2), 334.
4. Corbridge, D, F. C. and Cox, E. G., *J. Chem Soc.* (*Lond.*). 1956, p. 954
5. Higgins, G. M. C. and Saville, B, *Ibid.*, 1963 p. 2812.
6. Graddon, D. P. and Weeden, D. G., *Austral J. Chem.*, 1963, **16**, 980.

KAEMPFEROL 3-O-RHAMNOGALACTOSIDE : REVISED STRUCTURE FOR A GLYCOSIDE IN THE LEAVES OF *GLIRICIDIA MACULATA*

IN an earlier communication[1] from these laboratories on the chemical components of the leaves of *Gliricidia maculata* Steud, it was reported that the alcoholic extract contains a flavonol glycoside made up of kaempferol, D-glucose and L-rhamnose. Its spectral properties including shifts with selected reagents and its colour reactions indicated that the sugars were attached to the 3-hydroxyl of the aglycone. Based on the similarity of R_f values of our glycoside with those of 3-O-rhamnoglucosyl-kaempferol as reported in the literature[2] our glycoside was considered to be the same as this glycoside. But different m.p.s have been reported by different workers for what they consider to be kaempferol-3-rhamnoglucoside; 156-58° (hydrated),[3] 191-93° (anhydrous),[3] 180-82° with sintering at 148°[2] and 222-23°.[4] Our own m.p. was 218-26°. The differences in m.p.s could be due to different modes of linking between the sugar units. In order to ascertain this feature in our glycoside, it was subjected to permethylation employing the method of Hakomori[5] and the permethylate hydrolysed using Kiliani's mixture. The resulting partially methylated sugar fragments were examined by paper chromatography employing 2, 3, 4, 6-tetra-O-methyl-D-glucose as reference and two different solvent systems for irrigation. In the solvent system n-butanol : ethanol : water, 5 : 1 : 4, upper layer, two spots having R_G values 1·01 and 0·71 were obtained. According to the literature[6] the former corresponds to 2, 3, 4-tri-O-methyl L-rhamnose and the latter to 2, 3, 6-tri-O-methyl-D-galactose. Literature[6] R_G values of 2, 3, 4-, 2, 3, 6- and 2, 4, 6-tri-O-methyl-D-glucoses are 0·85, 0·83 and 0·76 respectively. The R_G value for 3, 4, 6-tri-O-methyl D-glucose in this solvent system is not available in the literature and was therefore determined now by the hydrolysis of permethylated graveobioside B[7] and was found to be 0·84. In the other solvent system, n-butanol : water : carbon tetrachloride, 4 : 4 : 3, lower layer, the R_G values obtained with our unknown sugar fragments were 0·37 and 1·03. These correspond to 2, 3, 6-tri-O-methyl-D-galactose[8] and 2, 3, 4-tri-O-methyl-L-rhamnose[8] respectively. In this system for all the four most probable tri-O-methyl-D-glucoses R_G values higher than 0·48 have been reported.[9] It therefore appeared that our earlier identification of one of the sugars present in our glycoside as D-glucose was not correct. This was quite plausible since the R_f values of D-glucose and D-galactose are so close in most solvent systems that they do not undergo clear separation in circular paper chromatography or in descending or ascending paper chromatography of short runs. We have therefore re-examined the sugars obtained by the hydrolysis of our glycoside by descending paper chromatography using a system specially suited for distinguishing between D-glucose and D-galactose, *viz.*, n-butanol : pyridine : water, 6 : 4 : 3, running the chromatogram for 30 hr and employing D-galactose and D-glucose for direct comparison. The sugar present in the glycoside in question was found to be only D-galactose. These results, therefore, necessitate a revision of the structure of our glycoside to L-rhamnopyranosyl (1 → 4) D-galactopyranosyl (1 → 3)-O-kaempferol. The natural occurrence of rhamnogalactoside of kaempferol has not been reported in the literature so far.

The authors thank Professor T. R. Seshadri for his kind interest.

Dept. of Chemistry, University of Delhi, Delhi-7, *Nov.* 27, 1970.
V. HARIHARAN.
S. RANGASWAMI.
V. SUBRAMONI IYER.

---

1. Rangaswami, S. and Iyer, V. S., *Curr. Sci.*, 1966, **35**, 364.
2. Murti, V. V. S., Raman, P. V., Seshadri, T. R. and Thakur, R. S., *J. Sci. Ind. Res.* (India), 1962, **21 B**, 80.
3. Kebayashi, K. and Hayashi, K., *J. Pharm. Soc. Japan*, 1952, **72**, 3.
4. Hukuti, G., *Ibid.*, 1939, **59**, 258.
5. Hakomori, S., *J. Biochem.*, 1964, **55**, 205.
6. Lederer, W. and Lederer, M., *Chromatography*, Elsevier Publishing Company, London, 1957, p. 249.
7. Rangaswami, S. and Seshadri, R., Unpublished work.
8. Tschesche, R. and Wulff, G., *Tetrahedron*, 1963, **19**, 621.
9. — and Ziegler, F., *Ann. Chem.*, 1964, **674**, 159.

THE EFFECT OF PHENYLHYDRAZINE ON GLUCOSE-6-PHOSPHATE DEHYDROGENASE (EC 1.1.1.49.) LEVELS IN RICE MOTH LARVA (*CORCYRA CEPHALONICA* ST.)

STUDIES on the effects of phenylhydrazine observed in rats, mice and rabbits have indicated that the activities of many enzymes like lactic dehydrogenase,[1] succinic dehydrogenase,[2] catalase,[3,4] glutathione reductase,[5] acid phosphatase,[6] ATP-ase[7] were affected. Since phenylhydrazine produces haemolytic anaemia,[8] it was of interest to study its effect on the enzyme glucose-6-phosphate dehydrogenase, (G-6-PDH) an enzyme involved in some types of hereditary and a few drug induced anaemias.[9] The rice moth larva has been chosen as a test organism since it has a well-defined metamorphosis and its use as a biochemical tool in toxicology and nutritional studies, as well as in a number of enzymatic studies have been reported.[10]

15 g. lots of whole wheat flour were distributed in a number of petri-dishes. Phenylhydrazine solution in varying concentrations from 30 to 90 mg./dish were added to the diet, dried at 80° C., and uniformly mixed. About 30 larvae of 12 to 15 days old were picked out at random from the stock colony and were put in the prepared diets. At the end of 10th day, 10 larvae were picked out from each dish, made free from adhering diet and weighed. The larvae were then homogenized using physiological saline[11] containing $6 \cdot 6 \times 10^{-4}$ M EDTA in the ratio of (0·05 ml./mg. larva) in a Potter-Elvehjem homogeniser for 1 mt. at 0-2° C. The homogenate was centrifuged for 20 min. at 0° C. at 25,000 r.p.m. in an international PR-2 refrigerated centrifuge. The clear supernatant fraction was used for the enzyme assay. Protein in the supernatant fraction from the homogenate was measured using the method of Lowry[12] with bovine serum albumin as the standard. The assay of G-6-PDH was carried out following the method of Ells and Kirkman.[13] The activities were expressed in milli-international units/mg. protein, and the overall estimations were carried out within 2 hr. of the preparation of the homogenate.

The G-6-PDH level of larvae during growth, fed on a normal diet, is presented in Fig. 1. The results of G-6-PDH level at the peak activity time of the larvae fed on diet containing phenylhydrazine in varying concentrations, are given in Fig. 2. Table I gives the weight of the larvae and the percentage inhibition of G-6-PDH levels.

TABLE I

The effect of phenylhydrazine on the G-6-PDH activity of the rice moth larva (Corcyra cephalonica *St.*) *homogenates and their units of activity expressed as given under experimental procedure*

Phenyl-hydrazine in mg.		Weight of larva in mg.	G-6-PDH activity in m.I.U./mgm. protein	Percentage inhibition
Control	..	18	66	..
30	..	18·7	55	16·7
60	..	20·0	42	36·3
90	..	12·2	38	42·4

From Fig. 1 it can be seen that the G-6-PDH level of larvae during growth increases progressively from the eighth day with a peak period of activity between the 12th and 13th days. The G-6-PDH activity of larvae reared in diet containing varying concentrations of phenylhydrazine was measured at the 12th day, since during that period only, maximum activity of the enzyme has been observed (Fig. 1). The growth rate of the larvae as well as the percentage inhibition of the enzyme given in Table I clearly indicate that as the concentration of phenylhydrazine is increased the G-6-PDH level decreases to about half the original level only at a concentration of 90 mg./dish. It is very interesting to note that phenylhydrazine upto a concentration of 50 mg. does not show any toxic symptoms, nor does it show any deleterious effect on the nutritional status of the larva as seen from the weight of the larva. The enzyme G-6-PDH is known to occur in multiple molecular forms.[14] According to Fig. 1 drop of the enzyme activity to the basal level on the 14th day shows a general recognition of the existence of multiple molecular forms (isoenzymes). The effect of phenyl-

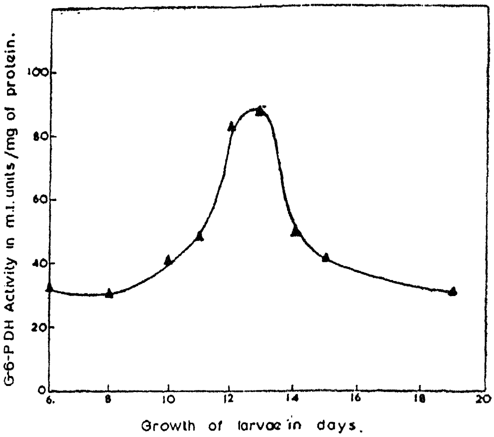


FIG. 1

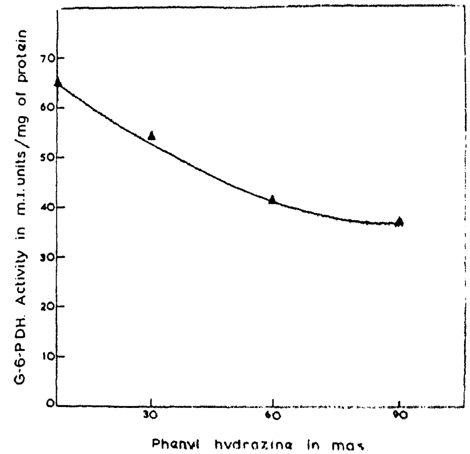


FIG. 2

hydrazine with respect to G-6-PDH activity (Fig. 2) may be viewed on the basis of selective inhibition of some isoenzymes by phenylhydrazine. It is known that G-6-PDH is a key enzyme in the pentose phosphate pathway and a detailed study of which may throw more light on our investigations.

The authors wish to thank the Indian Council of Medical Research for financial assistance to one of us (N. S. R.).

Univ. Biochem. Labs., G. Ranganathan.
Madras-25, N. S. Ranganathan.
November 9, 1970. E. R. B. Shanmugasundaram.

---

1. Asami, K. and Ozawa, H., *Seikagaku*, 1964, **36** 730.
2. Stopp, G., *Arch. Exptl. Pathol. Pharmakol.*, 1959, **67**, 286.
3. Alfred Gajdos and Marianne Gajdos, *Torok. Compt. rend. soc. Biol.*, 1957, **151**, 457.
4. Malachovskis, A., *Chemical Abstracts*, 1965, **62**, 12354.
5. Boivin, P., Francoise Haguenau, Galand, C. and Fauvert, R., *Ibid.*, 1965, **63**, 3448.
6. Bottini, E. and Modiano, G., *Experientia*, 1965, **21**, 379.
7. Reddi, T. G. and Nath, M. C., *Can. J. Biochem.*, 1969, **47**, 297.
8. Dacie, J. V., *The Haemolytic Anaemias—Congenital and Acquired*, Part 4, J. and A. Churchill Ltd., London, 1967.
9. Ben-Ishay, D. and Izak, G., *J. Lab. Clin. Med.*, 1964, **63**, 1002.
10. Yesodha Ganti and Shanmugasundaram, E. R. B., *J. Exptl. Zool.*, 1963, **153**, 251.
11. Bergmeyer, H. U., In *Methods of Enzymatic Analysis*, Academic Press, 2nd Edition, 1965.
12. Lowry, O. H., Rosenberg, N. J., Farr, A. L. and Randall, R. J., *J. Biol. Chem.*, 1951, **193**, 265.
13. Ells, H. A. and Kirkman, H. N., *Proc. Soc. Exp. Biol. Med.*, 1961, **106**, 607.
14. Hopkinson, D. A., *Advances in Clinical Chemistry*, 1968, **2**, 21.

LABORATORY REARING OF *BALANUS AMPHITRITE COMMUNIS* (D.)

In recent years considerable efforts are being made to rear barnacles under laboratory conditions to obtain their cyprids for the screening of antifouling chemical compounds. Laboratory methodology for the rearing of temperate species with the above objective in view has been developed by Wisley[1] in Australia, Freiberger and Cologer[2] in the U.S.A. and by Tighe-Ford and his colleagues[3] in the U.K. Costlow and Bookhout[4] examined larval development of *Balanus amphitrite denticulata* (B.) reared in the laboratory. This note gives a short account of the technique developed for the rearing of a common ship-fouling species *Balanus amphitrite communis* (D.).

Amongst larviparous species encountered in Indian waters, *B. a. communis*, *B. a. variegatus* (D.), *Chthamalus malayensis* (P.). *Ch. withersi* (P.) and *Tertraclita* sp. are the dominant ones and their breeding pattern in Bombay waters has been earlier examined.[5] Of these, the first three named species are considered suitable for obtaining cyprids under controlled laboratory conditions.

The sea-water for the maintenance of the gravid adult barnacles and for rearing of the larval young ones was pumped from the harbour area. Twenty-four hour standing sea-water was passed through coarse glass-wool filters before its use in the rearing jars. The temperature of the water was 25° to 28° C. and the salinity was 25 to 30 ppt.

For the successful completion of the larval metamorphosis, an availability of the supplementary food at adequate concentration is an important consideration. The dietary requirement of each barnacle species being specific, it is necessary that most suitable diatom or flagellate food for each species is determined. Some of the diatom species reported to be helpful are *Skeletonema costatum, Phaeodactylum tricornutum, Cyclotella nana, Coscinodiscus* sp. and *Biddulphia* sp. In our investigation, we examined eight diatom and two flagellate species for their dietary value. It is observed that *Dunaliella primolecta* supports good larval development of *B. a. communis* and *Chthamalus* species reared in the laboratory. It is suggested that use of dried liver powder or invertebrate eggs or blood as a supplementary food may be avoided since it encourages bacterial growth in the culture jars.

Earlier reports have suggested that the metamorphosis in temperate species is influenced by the ambient water temperature.[1,3] Barnes and Barnes[6] have also reported their views on the subject. In the present study the quantitative effect of temperature on the development of *B. a. communis* has not been examined. It is, however, observed that at 25° C., the metamorphosis under laboratory conditions progresses most satisfactorily.

Tighe-Ford *et al.*[3] have emphasised the importance of varying light intensity on the rate of growth of the larvae. They observed that under totally dark conditions, the metamorphosis was slower than that noted under condition of constant illumination. We have observed that larvae of *B. a. communis* undergo complete metamorphosis both under constant illumination and conditions of alternate day and night illumination.

The efficacy of antibiotics used for reducing bacterial growth in the rearing jars is debated.[1-3,7] In the present study use of antibiotics (penicillin and streptomycin) proved beneficial and it is recommended that for the successful completion of the metamorphosis, freedom from bacteria is ensured.

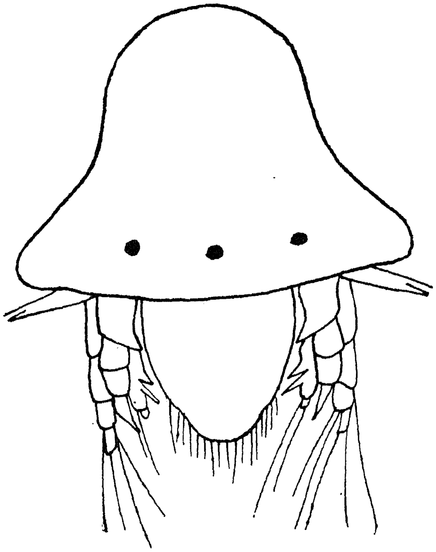


FIG. 1. Sixth nauplius stage of *Balanus amphitrite communis* (D).

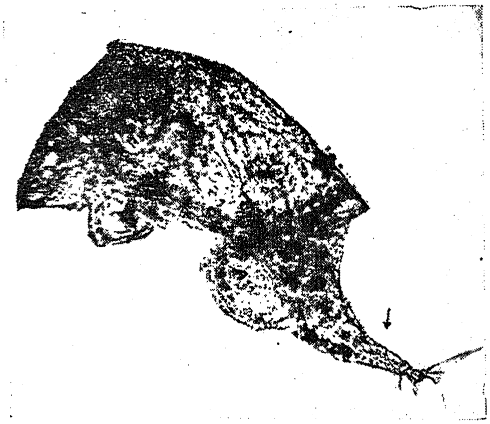


FIG. 2. Cementing organ of cypris of *Balanus amphitrite communis*.

The time required for complete metamorphosis into cypris varies from species to species of barnacle and generally depends on the rearing technique. An availability of food, however, is an important factor. Moyse[7] obtained cyprids of *Elminius modestus* within 6 days, whereas Wisely[1] reported their emergence within 15 to 20 days. In the present study cyprids of *B. a. communis* were obtained within 5 to 11 days. Nauplii having failed to emerge into cyprids survived as long as 21 days and cyprids having failed to settle under experimental conditions generally survived for a period of 3 days.

Nauplius of *B. a. communis* at stages I, IV and VI measure 180 μ, 300 μ and 420 μ respectively in overall length (Fig. 1). Cypris of this species measures 480 μ to 500 μ in carapace length (Fig. 2). Cypris of *Elminius modestus* measures 515 μ to 576 μ and that of *Balanus balanoides* (L.) measures 1,000 μ.

The authors are grateful to Shri C. P. De, Director of this Laboratory, for helpful suggestions.

Naval Chemical and
Metallurgical Lab.,
Lion Gate, Bombay-1,
November 26, 1970.

A. A. KARANDE.
M. K. THOMAS.

---

1. Wisely, B., *Aust. J. mar. Freshwat. Res.*, 1960, **2**, 42.
2. Freiberger, A. and Cologer, C. P., *J. Am. Soc. nav. Engrs.*, 1966, **78**, 881.
3. Tighe-Ford, D. J., Power, M. J. D. and Vaile, D. C., *Helgolander wiss. Meeresunters*, 1970, **20**, 393.
4. Costlow, J. D. and Bookhout, C. G., *Biol. Bull. mar. biol. Lab.*, *Woods Hole*, 1958, **112**, 313.
5. Karande, A. A., *Proceedings, 2nd International Congress on Marine Corrosion and Fouling*, Greece, 1968.
6. Barnes, H. and Barnes, M., *Limnol, Oceanogr.*, 1958, **3**, 29.
7. Moyse, J., *Nature, Lond.*, 1960, **185**, 120.
8. Jane Walley, L., *Phil. Trans. Royal Soc.*, 1969, **256**, 237.

OCCURRENCE OF *KLOSSIELLA MURIS*, SMITH, 1889 IN THE KIDNEY OF A MOUSE

SMITH,[1] and Smith and Johnson[2] described a coccidium found in the epithelium of convoluted tubules of the kidney of a mouse and named the parasite as *Klossiella muris*. Since then the parasite has been recorded in the kidneys of mice from different parts of the world. The purpose of this note is to place on record its occurrence in India.

During the routine post-mortem examination of healthy mice which are received at this laboratory from different divisions of this Institute and those utilized for experimental purposes in the laboratory, kidneys of mice showing any macroscopical abnormality were collected for histopathological examination in

10% formol-saline. They were processed through conventional methods, and as a routine were stained by haematoxylin and eosin. Other stains used were Wolbach's modification of Giemsa, Perrin-Goodpasture technique and Hotchkiss's modification of periodic acid-Schiff technique for organisms and protozoan parasites.

One of the kidneys (Sp. No. 313 Ex/69) revealed changes associated with the presence of *Klossiella muris*. Macroscopically, the cortical surface of the kidney had a granular appearance. Microscopically, the striking feature was the presence of parasitic cysts in the glomeruli and in the proximal and distal convoluted tubules of the cortex of the kidney. The parasitic stages recognized were multiple sporocysts and spores within the lumen of the tubules (Fig. 1), sporoblasts each with its nucleus at its distal end which appeared to bud out from a large central mass, sporozoites still attached to the restiform body and the falciform bodies. Except for the presence of parasites, the cortex and medulla failed to reveal any other changes of pathological significance.

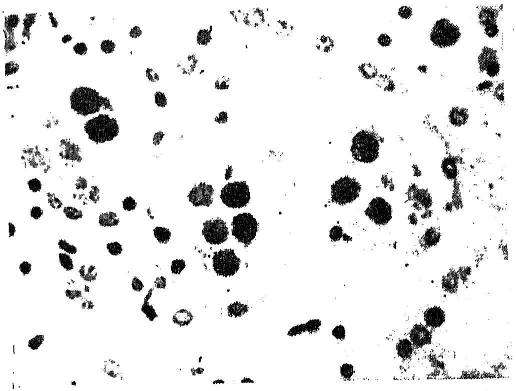


FIG. 1. Lumen of kidney tubules showing multiple sporocysts and spores. Giemsa, × 500.

Most of the parasitic stages identified in the present study resembled those described by Smith and Johnson.[2] It has been pointed out by Cotchin and Roe[3] that a high incidence of the parasite is usually associated with poor hygiene. Occurrence of the parasite only in one of the 154 kidneys examined indicates that the infection is rather sporadic in the mouse colony.

Disease Investigation Dept., C. F. MATANEY.
Division of Pathology, K. C. BHATIA.
Indian Vet. Res. Inst., P. K. R. IYER.
Izatnagar (U.P.), *September* 16, 1970.

---

1. Smith, T., *J. Exp. Medicine* & *Surgery*, 1889, **10**, 211.
2. — and Johnson, H. P., *J. Exp. Med.*, 1902, **6**, 303.
3. Cotchin, E. and Roe, F. J. C., *Pathology of Laboratory Rats and Mice*, Blackwell Scientific Publications, Oxford, 1967.

OCCURRENCE OF SYMBIOSIS IN SPECIES OF *AMARANTHUS*

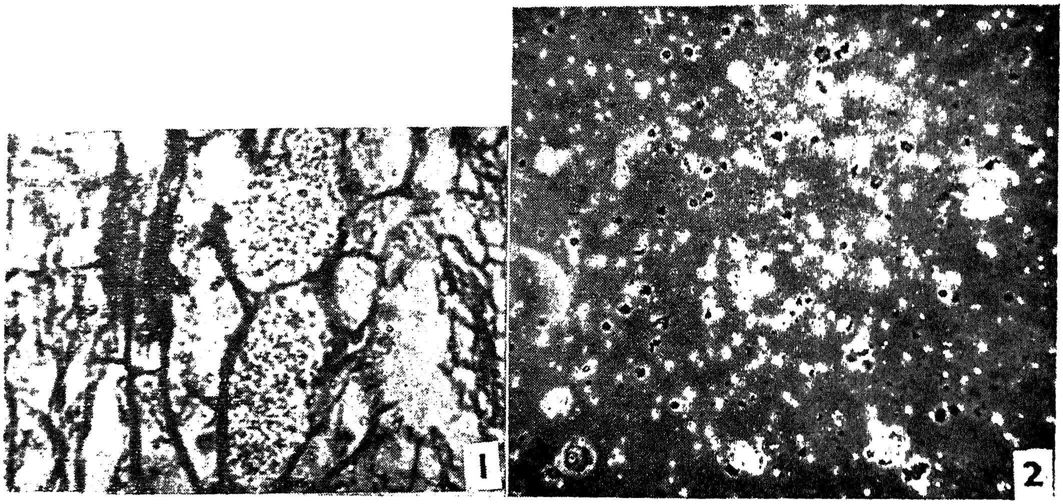
IN pursuance of the International Biological Programme, a search was made for new instances of symbiosis amongst weed plants in the tropics. This search was suggested by the review by Bond[1] drawing attention to symbiotic nitrogen fixations in some non-leguminous trees and shrubs.

Early success in this search was secured with a species of *Amaranthus*, tentatively identified as *Amaranthus oleraceus*. In the root system of this common plant, nodule-like structures were frequent. Microscopic examination of hand sections using fresh mounts showed that these structures were not due to nematode infection.

The presence of colonies of a micro-organism was easily observable. This observation was confirmed by microtome sections. These dense colonies did not stain when crystal violet and iodine combination was used for staining. Even Delanfield's Haematoxylin stained these bodies very lightly.

In order to determine whether the micro-organism contributed to the nitrogen metabolism of the host, young plants were grown in a nitrogen-free water culture and the plants showed normal growth. This experiment and an experiment to determine the effect of varying pH of water culture on nodulation and growth was reported elsewhere (Parija *et al.*[2]).

Further search showed that the characteristic colonies were consistently found in the stem as well as the tap-roots of *Amaranthus viridis* L., *A. spinosus* L. and also the cultivated group of vegetable Amaranths generally classified as *A. gangeticus* L. These colonies were located tangentially in the cortex, appearing as elliptical patches, caused by enlarged cells filled with the organism and also as larger areas caused by the lysis of host cells. The appearance of such colonies in a transverse section of the tap-root is shown in the photomicrograph in Fig. 1. It is evident that the organism which is widely distributed in shoots and roots of all the plants examined is important to the host. The cultivated Amaranths are easily grown, almost in every kind of soil without use of fertilizers. Some of them are of fast growth and the leafy vegetable can be harvested in 60 days. The weedly species *A. viridis* and *A. spinosus* are successful and colonise grazed or disturbed soils. Therefore, the micro-organism is probably beneficial to the host and is not a pathogen.



FIGS. 1–2. *Amaranthus gangeticus*. Fig. 1. Enlarged cells. Fig. 2. Cell contents by phase contrast.

The identification of the organism has proved difficult. In experiments to isolate the organism, bacteria were regularly found. Search was made for blue-green algal species and one isolate was grown in a nitrogen-free *Anabaena* medium and also on a solid agar medium. This isolate was identified by Dr. H. Pattnayak of Ravenshaw College as a species of *Fischerella*. This species is filamentous and includes heterocysts. A brief report on this organism was made by Professor Parija and associates in a local publication.

Further study of fresh mounts of sections of *Amaranthus* plants suggested that the situation may be more complex. The algal species could be a secondary infection confined to the root system. The main organism is a bacterium which is distributed throughout the plant. Sections of leaf stalk showed both the dense colonies in some cells and other stages of the micro-organism in other cells. The bacteria are initially small and rounded, but when larger, the angular shape is distinct. The photomicrograph in Fig. 2 gives the appearance of the organism from crushed cells. Since similar observation has not been reported previously from any plant species, there is need for further work and this is being done. It is inferred that the compact colonies correspond to the *bacteroid* stage of the organism.

The isolation and identification of the organism is an essential part of the work. Since the *Amaranthus* species listed are widespread or easily grown, the checking of the findings can be done easily. The purpose of this note is to draw the attention of those interested in this field to an interesting problem. This could be of economic interest since the Amaranths are universally used as vegetable and constitute a good source of vitamins and minerals.

Central Rice Res. S. SAMPATH.
Institute, and
Ravenshaw College, RABINDRA KUMAR MISHRA.
Cuttack, *November* 20, 1970.

---

1. Bond, *Ann. Review Plant Physiol.*, 1967, **18**, 107.
2. Parija, P., Pattnayak, H. and Mishra, R. K., *Ind. Sci. Cong.*, 1969, Section VI, p. 405 (Abstract).

BEIJERINCKIA INDICA DERX AS NITROGEN FIXER OF PADDY CROP IN ACIDIC SOILS OF MAHARASHTRA

Beijerinckia is restricted to acid laterite soils of the State. Therefore, it was isolated from soil samples of Amgaon (Dist. Bhandara), Shindewahi (Dist. Chandrapur), Phondaghat (Dist. Ratnagiri) and Mahableshwar (Dist. Satara). It was found that it grew best at pH 4. Altogether 16 cultures were isolated and their nitrogen-fixing capacity was determined which varied from 7 to 9 mg. N/gm. of suc-

TABLE I

Results of the pooled analysis of Beijerinckia *trials at Dapoli, Pomendi and Nive*

(Yield figures in Kg./hectare)

Treatment	Dapoli		Pomendi		Nive	
		% increase over control		% increase over control		% increase over control
Control ..	2838	..	4962	..	2472	..
Beijerinckia ..	3197	12·64	5321	7·23	2472	..
Molybdenum ..	2946	3·70	5188	4·56	2479	0·29
Beijerinckia + Molybdenum ..	3330	17·45	5881	18·51	2544	2·90
S.E. ..	65	..	128	..	26	..
C.D. ..	132	..	443	..	54	..

rose. The best culture, isolated from Phondaghat soil, was used for field trials.

The field trials with *Beijerinckia* were conducted on statistically laid out basis at five places (Dapoli, Shirgaon, Pomendi, Palshet and Nive) in Ratnagiri District for three years. The details of the trials are as follows:

Layout.—Randomised block design.

Replications.—Six.

Plot size.—25′ × 12′ net, 31′ × 18′ gross.

Treatments.—(1) Control. (2) *Beijerinckia* inoculation. (3) Molybdenum at 320 g./acre. (4) *Beijerinckia* + Molybdenum.

Normal cultivation practices and fertiliser doses were followed. Inoculation of paddy seedlings before transplanting was done by dipping the roots in the slurry of *Beijerinckia* prepared by mixing it in soil and water.

The following conclusions were drawn from the individual years' as well as the pooled analysis. The trials were significant at three places, *viz.*, Agricultural College Farm, Dapoli, Taluka Seed Farms, Pomendi and Nive. The treatment *Beijerinckia* + Molybdenum was found to be highly significant in individual years' as well as in pooled analysis. The treatment *Beijerinckia* alone was also significant, but the treatment *Beijerinckia* + Molybdenum was significant over *Beijerinckia* alone. The summary results of the pooled analysis are given in Table I.

From Table I it is evident that as the treatment effect of *Beijerinckia* alone, there was increase in yield to the tune of 12·64%, 7·23% and 0% at Dapoli, Pomendi and Nive respectively. As a result of the treatment effect of *Beijerinckia* + Molybdenum, the increase in yield was found to be 17·45%, 18·51% and 2·90% at Dapoli, Pomendi and Nive respectively.

The authors wish to thank I.C.A.R., Dr. V. P. Bhide and Shri V. D. Jagtap for the initiation of the work.

Biological Nitrogen
Fixation Lab. of Agric.
Bacteriologist,
Agric. College, Poona-5, November 12, 1970.
M. SULAIMAN.
D. G. GAIKWAD.

---

1. Dobereiner, J. and Fernandode Castro, "Occurrence and nitrogen-fixing capacity of bacteria of genus *Beijerinckia* in the soil series of Centro," *Nacional de Ensimo e Pesquisas Agronomica. Bol. Inst. E. Cal. e. Expl. Agric.*, 1955, **16**, 5. (Abstract in *Biol. Abstr.*, 1957, p. 8597.)
2. —, "Studies on the occurrence of *Beijerinckia* in some Brazilian states," *Rev. Brasil Biol*, 1959, **19** (2), 151. (Abstract in *Biol. Abstr.*, 35, 42529.)

INDOLE ACETIC ACID SYNTHESIS AND VIRULENCE OF DIFFERENT RACES OF *PYRICULARIA ORYZAE*

THE phenomenon of hyperauxiny or increased auxin levels in plants infected with pathogens has been well recognized. Pilet[1] suggested that this might result either due to the synthesis of auxins by the pathogen or synthesis by the host or a cumulative synthesis by both host and pathogen. Although Watanabe[2] and Sridhar[3] detected indole acetic acid (IAA) in the mycelial extract and culture filtrate, respectively, of the rice blast fungus *Pyricularia oryzae* Cav., only little information is available on the exact role of IAA in the host-parasite interactions and on the relation between virulence of races of pathogens and their IAA producing potential. An attempt has been made here to correlate virulence with IAA production.

Aliquots of 50 ml. of Czapeck's broth containing 0·1% L-tryptophan were dispensed in 100 ml. Erlenmeyer flask, sterilized and inoculated with 4 mm. discs of five races of *P. oryzae* of varying virulence. The flasks were incubated in darkness at room temperature (28° ± 2° C.) for 15 days. The mycelial mats were removed by filtration and their dry weight determined. IAA in the culture filtrate was extracted following the methods of Mahadevan.[4] The pH of the clear filtrates was adjusted to 3·0 with 1 N HCl and extracted three times with equal volumes of peroxide-free ether over 24 hr. in dark. The ether phase was evaporated to dryness at 30° C. and the residue was taken up in 2 ml. of pure methanol. IAA present in the methanol extract was determined following the method of Gordon and Paleg[5] using Salper's reagent (50 ml. of 35% perchloric acid and 1 ml. of 1 M $FeCl_3$). The colour development was allowed to proceed for 1 hr. in dark and read in a Spectronic-20 colorimeter at 535 mμ against reagent blank. The quantity of IAA was calculated from a standard graph. Detection of IAA in the extracts was done chromatographically by spotting 50 μl. of the extract on Whatman No. 1 filter-paper (27 cm. × 27 cm.), developing the paper in *n*-butanol : acetic acid : water : : 4 : 1 : 1 (v/v) solvent system ascendingly and sprayed with Salkowski reagent. The R_f value and colour of the spots were matched with the co-chromatographed authentic sample of IAA. The results are presented in Table I.

TABLE I

Variation in the mycelial dry weight and IAA synthesis in five races of Pyricularia oryzae

Isolate number	Reaction	*Mycelial dry wt.	†IAA production
AP 37	Virulent	113	65·08
M 5	Medium virulent	65	41·75
PO	Medium virulent	104	245·60
PBM	Medium virulent	122	52·80
M 4	Avirulent	88	71·22

* mg. on oven-dry basis. † μg/50 ml. of culture filtrate.

The IAA synthesising potential of *P. oryzae* greatly varies with the race of the fungus from 41·75 to 245·60 μg. of IAA per 50 ml. of the culture filtrate. IAA in the culture filtrate and the authentic sample had the same R_f values and colour of the spot. There appears to be no correlation between the quantity of mycelial growth and IAA production. The isolate PBM (medium virulent race) produced a maximum of 122 mg. of mycelial mat; however, it did not produce the maximum quantity of IAA. Interestingly, there seems to be no correlation between the quantity of IAA synthesized and virulence of the different races. The virulent race (isolate AP 37) produced only 65·08 μg. of IAA whereas a medium virulent race (isolate PO) produced 245·60 μg. of IAA. Also, the avirulent race (isolate M 4) produced more quantity of IAA than did virulent and medium virulent races. Hence, the relative IAA synthesising efficiency of these races does not form a measure of the virulence. Perhaps it is the combined activity of both the pathogen and the host *in vivo* which determines the hyperauxiny of a diseased plant. Further studies with races of different pathogens are required to confirm this finding.

The authors record their sincere thanks to Dr. N. N. Prasad, Reader in Microbiology, for his keen interest in these studies. They are highly grateful to Dr. G. Rangaswami, Dean, University of Agricultural Sciences, Bangalore, for his critical perusal of the manuscript. The financial assistance of United States Department of Agriculture through PL 480 grants is gratefully acknowledged.

Div. of Microbiology, D. PURUSHOTHAMAN.
Faculty of Agriculture, D. KANDASAMY.
Annamalai University, V. RAGUNATHAN.
Annamalainagar P.O.,
Tamil Nadu, India, *November* 24, 1970.

---

1. Pilet, P. E., *Phytopathol. Z.*, 1957, **31**, 162.
2. Watanabe, T., *Ann. Phytopathol. Soc.*, Japan, 1957, **22**, 143.
3. Sridhar, R., *Indian Phytopath.*, 1967, **20**, 379.
4. Mahadevan, A., *Phytopathol. Z.*, 1966, **57**, 253.
5. Gordon, S. A. and Paleg, L. G., *Physiol. Plantarum*, 1957, **10**, 37.

SEASONAL VARIATIONS IN THE SIZE OF CAMBIAL INITIALS IN *DALBERGIA SISSOO*

Dalbergia sissoo, the common timber-yielding tree of the family Fabaceae, was selected to investigate the seasonal variations in the activity of cambium and changes in the size of the cambial initials and related phenomena. The present investigation was aimed at determining whether or not the cambial initials undergo any seasonal variations in size. It was also intended to find out if any relationship exists between the size variations of the initial and cambial activity, since such an information is not available for tropical trees.

Periodic collections of the material were made during January to December 1968, in the second week of every month, from a tree growing in the University Botanical Garden. The material was fixed in Craf III. Blocks (1·5 cm × 2 cm), containing bark intact with a portion of wood were prepared with an electric saw and single-edge blades. Sections were cut in transverse and longitudinal planes with

[illegible]

[illegible]

[illegible]

TABLE I

[illegible]

Months		Fusiform initial* Breadth μ	Fusiform initial* Length μ	Ray initial* breadth μ
January	..	16·0	163·2	14·6
February	..	18·5	158·5	18·3
March	..	21·6	165·3	12·5
April	..	19·3	174·0	18·0
May	..	17·3	161·0	14·3
June	..	16·4	158·0	13·8
July	..	15·7	184·0	16·3
August	..	16·0	186·7	14·5
September	..	19·0	161·0	18·5
October	..	21·7	153·3	18·5
November	..	18·0	177·0	14·7
December	..	19·1	161·3	15·8

* Average of 25 values

[illegible] the fusiform initials have been reported towards the end of the active period. However, there is a sharp fall in length whereas they tend to be broader. There is no satisfactory explanation for the fluctuations in the size of ray initials but the marked feature is the sudden fall in their breadth in March when the cambial activity is initiated (see Fig. 1).

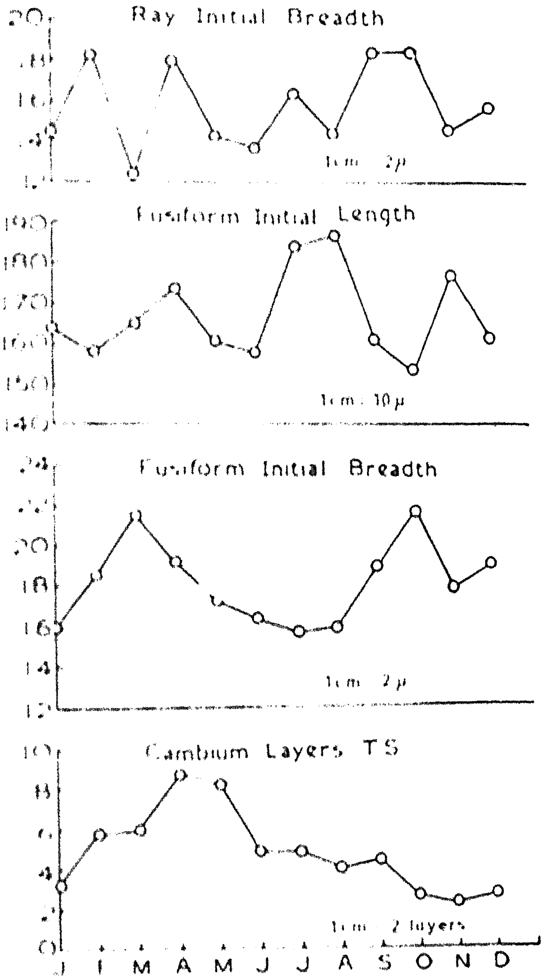


FIG. 1. Variations in the size of cambial initials during one year period (1968).

Thanks are due to Professor B. M. Johri for encouragement and facilities provided, and to Miss Lalita Kakkar who helped in collections of the material.

Dept. of Botany, G. S. PALIWAL.
Univ. of Delhi, N. V. S. R. K. PRASAD.
Delhi 7, *September* 11, 1970.

---

1. Cheadle, V. I., Gifford, E. M. Jr. Esau Katherine, *Stain Technol.*, 1953, **28**, 49.

OCCURRENCE OF *AVRAINVILLEA NIGRICANS* DECAISNE ALONG INDIAN COAST

DURING the study of the marine algal flora of Saurashtra coast, the authors came across an alga answering the description of *Avrainvillea nigricans* Decaisne. It is interesting to find this Atlantic species along the Indian coasts. The description of the Indian specimen is given below:

Avrainvillea nigricans DECAISNE

Boergesen, F. 1908, P. 30; 1913-20, Taylor, W. A., 1950, pp. 67-70.

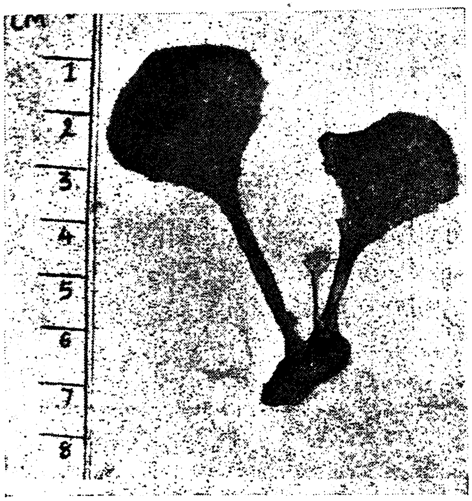


FIG. 1. Habit of *Avrainvillea nigricans* Decaisne from Adatra (Okha).

Plants 4-9 cm tall, arising gregariously from a basal mass of rhizoids and sand, stalked. Rhizoidal filaments less regularly moniliform, dichotomously branched, 28-99 μ diam.; yellowish in colour, with few to plenty starch grains; stipe 2·0-3·5 cm long, 3-5 mm thick, slightly terete below, flattened above and transitional into the flabellum. Flabellum oblong-reniform with more or less cuneate base, 1·0-6·0 cm long, 2·5-5·2 cm broad, soft leathery, faintly zonate with rounded or lacerated margin. Structural filaments moniliform, 33-79·3 μ diam. to the interior, upto 14 μ at the peripheral portion, dichotomously branched, with non-clavate apical ends; chromotophores numerous, oval to elongate, having one pyrenoid each; light brown colour, becoming slightly dark on drying, not adhering well to paper.

Habitat: On mud covered rocks in pools at the midlittoral level, Adatra (Okha).

Geographical Distribution: Florida, West Indies, Brazil.

This species is characterized by the regularly moniliform filaments and in not having the numerous small openings described by Boergesen (*l.c.*). The present species is very closely related to *A. ascarifolia* Boergs. from which it differs in the presence of regular moniliform structural filaments and also in having the peripheral filaments.

The other species of *Avrainvillea* described from India are *A. erecta* (Berkel). Gepp., *A. amadelpha* Gepp. and *A. ridleyi* A. and E. S. Gepp. (Ref. Dixit, 1968).

The authors are thankful to Prof. S. C. Pandeya for the facilities provided.

Dept. of Biosciences, Saurashtra University, Rajkot (Gujarat), *September* 29, 1970.

P. SREENIVASA RAO.
P. M. VADHAR.
Y. B. RAWAL.

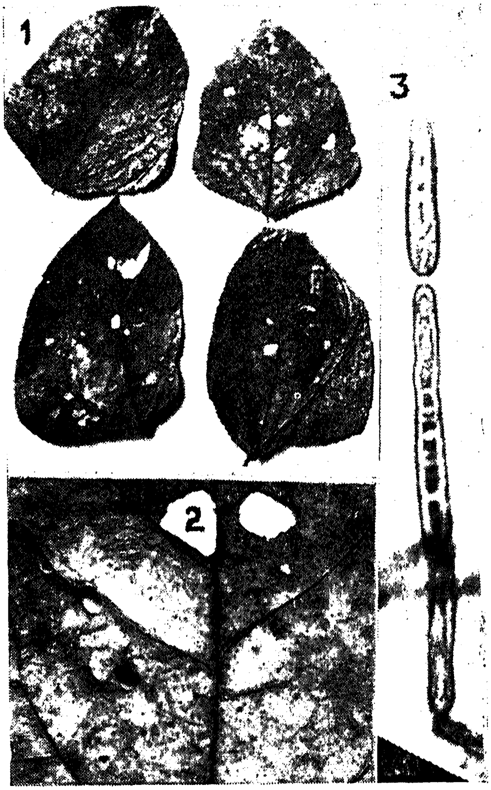
---

1. Boergesen, F., *Videnk. Medd. Natur. Fores.*, 1908, p. 27.
2. —, *Dansk. Bot. Arkiv.* 1913-20, **1** (4), 1.
3. Dixit, S. E., *J. Univ. Bombay*, 1967 and 1968, **36**, 15.
4. Taylor, W. A., *Plants of Bikini and Other Northeren Marshal Islands*, pp. 67.

CORYNESPORA LEAF-SPOT OF COW-PEAS [*VIGNA SINENSIS* (TORNER) SAVI.] A NEW RECORD TO INDIA

A SEVERE leaf-spot disease of cow-peas was observed by the authors during their frequent visits to the fields of the Agricultural College, Dharwar. Being a pulse crop, rich in proteins it is therefore grown in many parts of the country. As the leaf-spot disease was observed in most of the plants in severe form, it needed attention in respect of its cause and control measures. Microscopic examination of the sections through the infection spots revealed the presence of a dematiaceous hyphomycete and was diagnosed as a species of *Corynespora*. In India this genus is represented by about six species (Munjal and Gill, 1962). Referring to the literature it revealed that Olive *et al.* (1945) have reported *Helminthosporium vigniae* on leaves of *Vigna sinensis* and the same fungus has been referred to as *Corynespora cassiicola* by Spencer and Walters (1969). The comparative studies between the writers' collection and *Corynespora cassiicola* showed that they are similar in all the essential morphological characters and the symptoms produced. As this disease is observed for the first time in India, a brief description of the symptoms and etiology of the causal organism are presented here for ready reference.

Symptoms (Figs. 1 and 2).—Symptoms were noticed on leaves of different ages. In the earlier stages of infection, the spots were circular, the necrotic area being white to grey. In the severely affected leaves, the spots were circular to irregular with distinct concentric rings. In the advanced stages the necrotic spots coalesce appearing as patches. Sometimes major portion of the leaf is affected and such leaves easily fall down. Severe defoliation was the marked symptom in the advanced stages of infection. No symptoms on twigs.



FIGS. 1–3. Fig. 1. Diseased leaves showing spots of different developmental stages. Fig. 2. Enlarged view of single infection spot—note concentric rings. Fig. 3. Conidia in chain obtained from culture.

Pathogenicity.—The pathogenicity of *Corynespora cassiicola,* isolated from the infection spots, was proved by artificial inoculation of healthy leaves with the culture.

Etiology.—Mycelium sub-hyaline to brown, septate, 4-6 μ broad. Conidiophores simple, come out of epidermal cells, septate, dark brown, 50-300 μ long and 4-6 μ broad. Conidia produced singly at the tip of conidiophore, broader at the base and tapering at the tip, sometimes cylindrical, sub-hyaline to brown, pheo-phragmoid, 4-18-celled, 36-240 μ long and 6-18 μ broad.

The fungus was easily brought in culture on potato dextrose agar medium at the room temperature (27-28° C.). The fungus produced conidiophores and conidia typical of *Corynespora cassiicola* without much variation in dimensions. The interesting feature observed in the culture was the production of conidia in chains (Fig. 3) although production of single conidium at the tip of each conidiosphore was not uncommon, thus agreeing with the results of Olive *et al.* (1945).

The material of the above fungus is deposited at Herb. Orientalis, New Delhi, under No. 30044.

Our grateful thanks are due to Dr. S. W. Mensinkai, College of Agriculture, Dharwar, for encouragement and laboratory facilities.

Plant Pathol. Div., K. FAZALNOOR.
College of Agric., K. H. ANAHOSUR.
Dharwar-5, B. C. NARAYANASWAMY.
November 9, 1970.

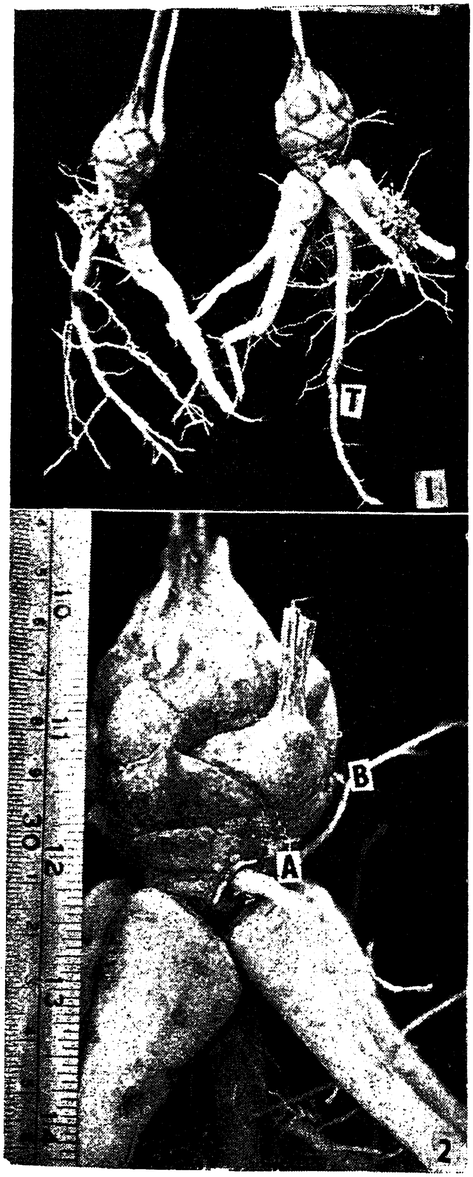
---

1. Munjal, R. L. and Gill, H. S., "Some dematiaceous hyphomycetes from India—I," *Indian Phytopath.*, 1962, **15**, 269.
2. Olive, L. S., Bain, D. C. and Lefebvre, C. L., "A leaf-spot of cow-pea and soybean caused by an undescribed species of *Helminthosporium*," *Phytopathology*, 1945, **35**, 822.
3. Spencer, J. A. and Walters, H. G., "Variations in certain isolates of *Corynespora cassiicola*," *Ibid.*, 1969, **59**, 58.

SWOLLEN ROOTS OF *CYCAS CIRCINALIS* L.

RIPE seeds of *Cycas circinalis* were sown in the soil and allowed to germinate. A number of them grew to seedling stages. They were examined periodically, with the idea of working out their anatomy. Seedlings of about three years showed some peculiar rootlets which arise on the tap-root but above the lateral apogeotropic coralloid roots and below the first pair of leaf-bases. Thus, their position appears to be adventitious. They vary in number from one to six per seedling. Though lateral in position they looked like *Raphanus sativus* root in appearance without its two vertical rows of lateral rootlets. Everything about these fleshy swollen roots appeared to be quite peculiar, deserving a detail description.

The seedling of 3-4 years old has a tuberous stem having 10-12 thick leaf-bases arranged in a spiral manner—some of them belong to the non-green and others to green functional leaves. All of them become thick with reserve starch and overlap the growing point of the stem. Some leaf-bases produce vegetative buds which act as propagula (Fig. 2 B). Down below, these seedlings send a tap-root into the soil which tapers to a point. The tap-root is long and tough and lateral rootlets sparingly produced on it. The previous workers, Chamberlain (1935), Schuster (1932) and Worsdell (1906), doubt the existence of the tap-root in the old plants of Cycads. In the seedling stage upto 5-6 years, the tap-root exists and functions normally. We can naturally expect the tap-root to exist even in older plants. In fact, no extensive work on the roots of Cycads has been done (Chamberlain, 1919).



FIGS. 1–2. Fig. 1. Two *Cycas* seedlings one showing one swollen root and the other five swollen roots. Fig. 2. Enlarged view of one of the seedlings of Fig. 1. Adventitious origin can be seen clearly. Young root taking its origin above a big root also seen at A, and a vegetative bud at B (T = Tap root).

The tap-roots of seedlings produce peculiar fleshy swollen roots 1-6 per plant. They are white or pearly white in colour. They bear few lateral rootlets or none at all. Their position is also adventitious arising on the hypocotyledonary region (Figs. 1, 2). The fleshy swollen roots are thin at the point of emergence from the main root and become suddenly swollen and gradually taper to a point. The largest diameter of the swollen root is 27 mm. and the length 200 mm. on an average, while the corresponding values for the tap-root are 14 mm. and 180 mm. respectively. The diameter of the tuberous stem varies from 50 mm. to 70 mm. There is no previous reference to such roots of *Cycas circinalis*. However, Byran (1936) has described fascicled roots of *Cycas revoluta*, where thin adventitious roots are produced in large numbers from the main root and they are in bundles of fascicles. They are not swollen as those of *C. circinalis*. The anatomy of the swollen root of *C. circinalis* is different from that of the tap-root. Further, there is structural evidence to show that these roots though swollen with water and soluble salts normally, can take up a function like that of a contracting root under dry condition and pull down the stem into the soil.

The author wishes to thank Dr. H. Narasimhaiah, Principal, National College, Bangalore, for permission to publish this note.

Botanical Laboratory, L. NARAYANA RAO.
National College,
Bangalore-4, *November* 13, 1970.

---

1. Byran, G. S., "Fascicled roots of *Cycas revoluta*," *Ann. Jour. Bot.*, 1936, **23**, 334.
2. Chamberlain, C. J., *Living Cycads*, Chicago, 1919.
3. —, *Gymnosperms Structure and Evolution*, 1935.
4. Schuster, J., "Cycadaceae," in Engler, *A Das Pflanzenreich*—4, Leipzig, 1932.
5. Worsdell, W. C., "The structure and origin of the Cycadaceae," *Ann. Bot.*, 1906, **20**, 129.

REVIEWS AND NOTICES OF BOOKS

Molecular Mechanisms in Memory and Learning. Edited by Georges Ungar. (Plenum Press, New York and London), 1970. Pp. xiv + 296. Price $ 15.00.

The idea that chemical principles are relevant to neural function has met with a great deal of skepticism in many scientific circles. Historically, the nervous system has been regarded essentially as a physical—particularly an electrical—machine, and only in the past 15 years has it become increasingly clear that many steps in the neural process are based on chemical principles. The molecular approach to neurophysiology provides the most recent, best-documented, and most controversial evidence of the relation of chemistry to neural function. To show its incalculable theoretical and practical significance for the future of the biological sciences is the broader purpose of this volume.

Providing the first multidisciplinary forum and consequent definition of the new science of molecular neurobiology, this book surveys advances made during the last decade in the molecular approach to the mechanism of learning and memory. After placing the problem in the framework of established data, the authors discuss the conditions for acceptance of the chemical hypotheses, present the experimental evidence, obtained by various methods, and interpret them from the biochemical, physiological, cybernetic, and behavioral points of view. The authors deliberately introduce opposing points of view, and therefore, produce a critical evaluation of the methods, results, and their own interpretations.

This volume will be found useful as an introduction to this new area in biological and behavioral sciences. C. V. R.

Free Nitroxyl Radicals. By Rozantsev. Translated from Russian by B. J. Hazzard. Translation edited by H. Ulrich. (Plenum Press, New York and London), 1970. Pp. xiv + 249. Price $ 19.50.

A study of the synthesis, structure, reactivity, and use of a new class of free radicals, this important monograph presents methods of obtaining individual nitroxyl radicals stable in air. Examining their main chemical reactions, this book, written by a pioneer in the field, considers dipole moments of these new radicals, their paramagnetic resonance spectra, heats of combustion and formation, their volatilities, kinetic measurements, and the dynamic polarization of their solutions.

Also presented are numerous practical use of nitroxyl radicals in chemical, physical, and biological research, in the study and stabilization of polymers, and as working substances in quantum generators and magnetometers.

C. V. R.

Chemistry of the Ionosphere. By A. D. Danilov. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011, U.S.A.), 1970. Pp. xv + 296. Price $ 22.50.

This is an English translation of the original Russian text published in 1967 and which has been corrected by the author for this edition.

The Chemistry of the Upper Atmosphere is a rapidly developing field of scientific research. It is being realised that a complete understanding of phenomena in the earth's atmosphere requires a detailed investigation of elementary processes, particularly chemical and photochemical processes.

This book attempts to present an integrated review of information on the most important aspects of the chemistry of the upper atmosphere, covering both laboratory investigations of the pertinent chemical processes and studies for clarifying the role and rate of these processes in the atmosphere.

The comprehensive nature of the problems discussed will be evident from the following chapter headings: Results of rocket investigations of parameters of the upper atmosphere; Elementary processes in the ionosphere; Rates of processes of dissociative recombination; Rate of ion-molecular processes; Ion formation in the ionosphere; Negative ions and the D-region; Oxygen dissociation; Reactions in which nitrogen and its oxides participate; Nitrogen dissociation; Reactions with participation of neutral and ionized hydrogen and helium atoms.

It should be mentioned that the problems discussed in this book are presented as matters stood late in 1965. A. S. G.

New Vistas in Crop Yields. (Indian Council of Agricultural Research, Dr. Rajendra Prasad Road, Krishi Bhavan, New Delhi), 1970. Pp. 710. Price Rs. 29·50.

This is the first of the *Agricultural Year-Books* proposed to be published by the Indian Council of Agricultural Research (ICAR). A major problem that bedevils India's progress to prosperity is how to reach self-sufficiency in food production. With the population explosion acting as a Tantalus-cup, it looks as though our efforts in this direction should be not only to grow two ears of corn where one grew before, but to bring under the plough two hectares of land where one was brought before. The ICAR with its multifarious operating units spread throughout the country has been endeavouring towards this goal, and it must be said, with a degree of success, in evolving high-yielding varieties of crops, developing dryland farming technology and arid zone researches.

In this first of the *Agricultural Year-Books* whose objective is to bring together the major results of researches that have a bearing on our agricultural strategy, specialists have given comprehensive accounts of the progress made in various fields of agricultural research. The topics include plant introduction and plant protection, genetic improvement of crops, agronomic practices, soil science, and agricultural engineering.

A. S. G.

ANNOUNCEMENTS

Indo-Soviet Conference on Solid-State Materials to be Held at Bangalore, 15-22 December 1971

The Conference is sponsored jointly by the Indian National Science Academy and the Academy of Science of the U.S.S.R. and is being organised by the Indian Institute of Science, Bangalore. The Conference is concerned with all aspects of solid-state materials and will comprise of contributed papers and selected presentations invited by the Conference. The following topics are planned to be included: (1) Materials preparation, structure, characterisation; (2) Optical and spectroscopic properties; (3) Magnetism and magnetic materials; (4) Dielectric properties of materials; (5) Physics of semiconductors and metals; (6) Solid-state theory; (7) High temperature and high pressure behaviour of materials; and (8) Materials technology, high strength materials.

Interested persons may kindly write to the Local Secretary, Indo-Soviet Conference on Solid-State Materials, Department of Physics, Indian Institute of Science, Bangalore-12, India.

Ninth General Assembly and International Congress of Crystallography

The Ninth International Congress of Crystallography, organised by the Science Council of Japan for the International Union of Crystallography and the Ninth General Assembly of the Union will be held in Kyoto, Japan, from August 26 to September 7, 1972.

Further details of the Congress, including arrangements for registration, transportation, accommodation, scientific visits, etc., will be described in the First Circular (an Information Booklet) which will be distributed in about September 1971.

Copies of these forms can be obtained from Prof. R. Srinivasan, Secretary, National Committee for Crystallography, Centre of Advanced Study in Physics, University of Madras, Guindy Campus, Madras-25, India.

Books Received

Composition Reaction and Equilibrium Experiments in Chemistry. By N. C. Craig, T. S. Carlton, M. N. Ackermann, R. C. Schoonmaker and W. B. Renfrow. (Addison-Wesley Pub. Co., Inc., 11, West End House, 11, Hills Place, London W. 1, England), 1970. Pp. x + 341. Price 39 *sh*.

Pre-Harvest Maturity in Sugar Industry. By S. C. Sen. (Subrata Sen, 113/226, Swarup Nagar, Kanpur-2), 1970. Pp. viii + 54. Price Rs. 15.

Agricultural Year-Book—New Vistas in Crop Yields. (Indian Council of Agricultural Research, Krishi Bhavan, New Delhi-1), 1970. Pp. vi + 710. Price Rs. 29·50.

Fourier Methods in Crystallography. By G. N. Ramachandran and R. Srinivasan. (John Wiley and Sons, Inc., 605, Third Avenue, New York, N.Y. 10016), 1970. Pp. xiii + 259. Price $ 15.95.

Clinical Toxicology—Snake Venoms and Envenomation. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y. 10016), Vol. 3, No. 3, September 1970. Pp. 343-517. Price $ 8.50.

2599-71. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, L.P.T., Superintendent, at The Bangalore Press, Bangalore-18.

DETERMINATION OF RUTHENIUM IN FALLOUT SAMPLES

S. B. HINGORANI AND M. SUBBA RAO

Air-Monitoring Section, Bhabha Atomic Research Centre, Bombay-85, India

INTRODUCTION

ANY radiochemical procedure to be followed for the analysis of fallout samples immediately after a nuclear weapon test should be rapid, quantitative, free from contamination due to other radioisotopes present in these samples and should have high chemical yields so that it can be used even for low activity samples. The most common methods available in the literature for the determination of ruthenium activity in mixed fission products are: (1) Distillation method,[1] (2) Non-distillation method using extraction technique.[2,3] As a part of our studies on fresh fallout for identification of nuclear weapon tests a method, based on non-distillation technique, has been adopted for the estimation of Ru-103 and Ru-106. The sample material is cotton swipe collected by rubbing the surface of commercial aircrafts arriving at Bombay, with cotton soaked in organic solvent.

Such samples are being routinely collected for estimating background levels. Immediately after the test, the sampling frequency is increased and detailed analyses are done to get information about the test, *e.g.*, fissile material, mode of detonation, etc.

SAMPLE LEACHING

The sample is digested with a mixture of 3 M hydrochloric acid and 0·1 M hydrofluoric acid in the presence of known amounts of carriers on a hot plate in a beaker. The heating time is reduced to a minimum to avoid silica of the glass-ware reacting with the hydrofluoric acid. The solution is then filtered through Buchner funnel using Whatman 54 filter-paper. This process is repeated 3-4 times and finally the residue is leached with 6 M nitric acid and filtered. All parts of the filtrate are then combined and only a known aliquot of this leach solution is used for the analysis.

CHEMICAL PROCEDURE

A known aliquot of the leached solution with added carriers is evaporated to dryness. The residue is taken in a small quantity of concentrated hydrochloric acid and evaporated again to dryness. This is repeated 2-3 times to bring the residue into chloride form. The residue is finally dissolved in about 10 ml of concentrated hydrochloric acid and transferred to 100 ml separating funnel. 10 mg of stable zirconium is added as a hold back carrier to the solution and the solution is neutralized with 12 M sodium hydroxide solution under running tap-water. After cooling, about 20 ml of sodium hypochlorite is added to the solution in the separating funnel and kept for 2 hours for complete oxidation of lower valency species.

In alkaline medium, ruthenium with hypochlorite forms perruthenate which is unstable compound in acid medium and decomposes to lower valency state, usually ruthenium tetraoxide. This ruthenium tetraoxide is easily extractable with carbon tetrachloride.[4]

After two hours' oxidation, equal volume of carbon tetrachloride is added with concentrated hydrochloric acid under cooling conditions and ruthenium is extracted from the solution by shaking for about five minutes. The organic phase is separated and washed with sodium hypochlorite in a fresh separating funnel. Ruthenium is then back-extracted from organic phase by equal volume of 6 M sodium hydroxide solution in presence of 10-15 mg of sodium bisulphite. The aqueous layer is separated and heated to boiling with a little alcohol. The precipitate is centrifuged, dissolved in concentrated hydrochloric acid and diluted to about 50 ml with distilled water. The ruthenium chloride thus obtained, is reduced to metallic ruthenium by addition of magnesium powder. Ruthenium is finally filtered through Whatman filter-paper 542 (22 mm disc), washed, dried under infrared lamp and weighed to find the chemical recovery. The chemical recovery is found to vary between 70-80%. The filter-paper disc with ruthenium precipitate is then mounted on a perspex planchet and counted in a beta-counting assembly.

COUNTING OF RUTHENIUM-103 AND 106

Ruthenium sample, with a thickness of 3-4 mg/cm^2 is counted through an aluminium absorber (60 mg/cm^2) in a low background beta-counting assembly using end-window GM counter. The absorber stops beta particles of Ru-103 (0·2 MeV) and Ru-106 (0·039 Mev) but allows most of the energetic beta particles of Ru-106 daughter product Rh-106 (3·5 MeV), to pass through. The necessary correction for the loss of Rh-106 betas in the absorber is made and this count rate is used to estimate the

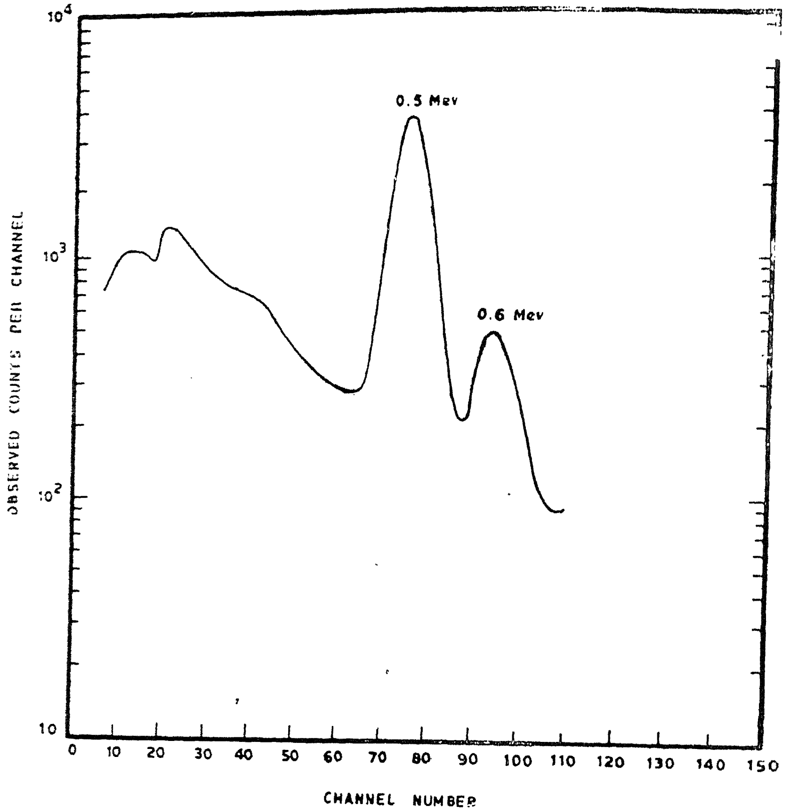


FIG. 1. Typical gamma spectrum of a separated ruthenium sample. The two peaks are due to Ru-103, Ru-106 and their daughters.

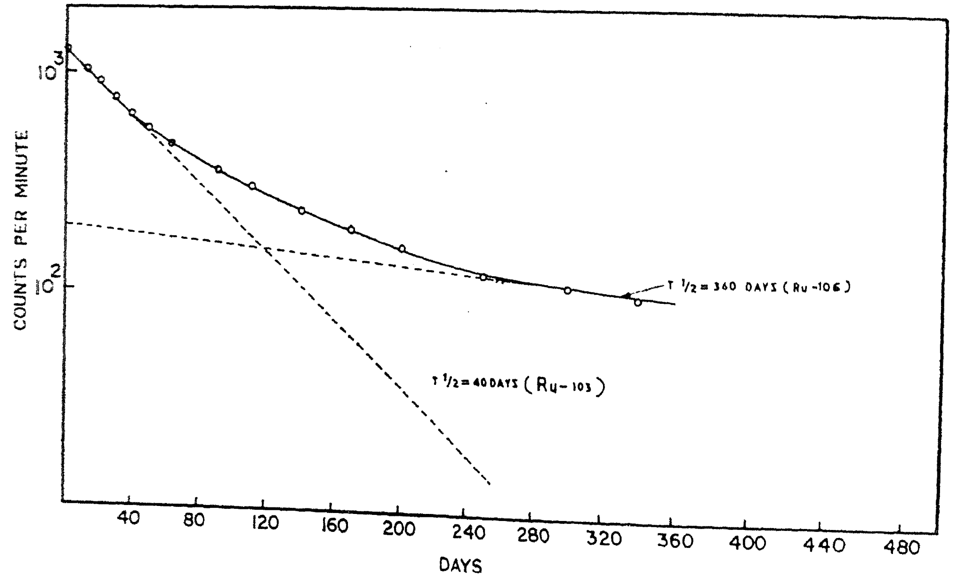


FIG. 2. Decay curve of Ru-103 and Ru-106

Ru-106 concentration in the sample. Ru-106 + Rh-106 contribution when subtracted from the count rate obtained without any absorber is used for estimating the contribution of Ru-103.

Normally, when Ru-103 activity is less than 10% of Ru-106 activity, Ru-103 cannot be determined with reasonable accuracy. The count rates are corrected for absorption, efficiency of the counter, chemical recovery, per cent disintegration and decay to obtain the activity.

RESULTS AND DISCUSSION

The chemical procedure described above is rapid and quantitative and ruthenium separated is free from contamination of other fission products. Figure 1 gives a typical gamma spectrum of a chemically separated sample of ruthenium and shows that only two prominent peaks due to Ru-103 + Rh-103 and Ru-106 + Rh-106 are present. Any contamination will be indicated by additional peaks in the gamma spectrum. The purity of the samples as well as the accuracy of the estimation can also be checked subsequently by following the radioactive decay of the sample using GM type low-level beta counter (Fig. 2).

The reproducibility of the chemical procedure has been established by quadruplicate analysis of two samples and results of this analysis are given in Table I. Ruthenium content (cpm) in the sample and the per cent deviation from the mean for each of the four aliquots are found to be within ± 10% of the average value. Similar experiments have also been done to confirm that complete isotopic mixing exists between the carrier and the radioactive ruthenium in the sample.

TABLE I

Results of quadruplicate analysis

Sample No.		cpm	% deviation from the mean
I	(1)	425·0	+4·4
	(2)	380·0	−6·6
	(3)	378·0	−7·1
	(4)	444·0	+9·1
II	(1)	415·0	−2·6
	(2)	410·0	−3·8
	(3)	422·0	−1·0
	(4)	458·0	+7·5

The activity levels of Ru-103 and Ru-106 for some of the samples collected and also their ratios are given in Table II. The values have been corrected to test dates and these dates are also given in the table. The first four ratios are of A-bomb tests with Pu-239 as the fissile material. The expected activity ratio of Ru-103/Ru-106 for this fissile material and type of fission is 9·4.[5] The variations in the first three observed ratios are due to the presence, in the sample, of old Ru-106 from earlier tests. The last four ratios are also of A-bomb tests using U-235 as the fissile material. The expected activity ratio of Ru-103 and Ru-106 for this fissile material is 78·4.[5] Here again the large variation in the observed ratio is primarily due to the contribution of old Ru-106 from previous tests. The concentration of fresh Ru-106 can be estimated from the measurements of other fission products such as Ba-140, Ag-111, etc., performed on the same samples. The expected ratio of Ba-140 or Ag-111 to Ru-106 and the measured concentration of Ba-140 or Ag-111 gives the concentration of fresh Ru-106 present in the sample. Presuming Ru-103 present in the sample to be fresh, the ratios of Ru-103 to the estimated fresh Ru-106 were taken and they were found to be in good agreement with the above expected ratios for the two-fissile materials. Thus, the present measurements are useful in providing supporting evidence regarding fissile material used in the weapon tests.

TABLE II

Ru-103 and 106 levels corrected to test dates in swipe samples

S. No.	Ru-103 uuc	Ru-106 uuc	Observed ratio Ru-103/106	Explosion date to which ratios are corrected
1	31,650	4,490	7·05	11—9-1966
2	86,500	12,490	6·93	24—9-1966
3	73,000	12,320	5·92	4-10-1966
4	1,12,000	9,840	11·40	2—7-1967
5	1,790	917	1·95	27-10-1966
6	9,900	2,045	4·84	28-12-1966
7	26,420	13,340	1·98	24-12-1967
8	2,300	1,630	1·42	24-12-1967

ACKNOWLEDGEMENT

The authors are thankful to Dr. K. G. Vohra, Head, Air-Monitoring Section, BARC, for the encouragement given during the course of this work. Thanks are also due to Shri B. Y. Lalit for his help in beta activity measurements.

---

1. Glendenin, L. E., *Radiochemical Studies : The Fission Products*, Book 3, Ed. C. D. Coryell and N. Sugarman, McGraw Hill, N.Y., 1951, Paper 260, p. 1549.
2. Rickard, R. R. and Wyatt, E. I., *The Radiochemistry of Ruthenium*, National Academy of Science, February 1961.
3. Meadows, J. W. T. and Matback, G. M., "Radiochemical determination of ruthenium by solvent Extraction and Preparation of carrier free ruthenium activity," *Analytical Chemistry*, 1962, **34**, 89.
4. Martin, F. S., "The distribution of ruthenium tetraoxide between carbon tetrachloride and aqueous alkali, acid and neutral salt solution," *J. Chem. Soc*, 1954, Part II, p. 2564.
5. Rangarajan, C. *et al.*. *Fission Products Data and Its Application in Studying Fallout From Nuclear Weapon Tests, Report No. AEET-209*, 1965.

SUITABILITY OF CERTAIN CARBON SOURCES FOR THE ENRICHMENT OF NITROGEN-FIXING BACTERIA FROM SALINE ALKALI SOILS

USHA KHANNA AND S. R. VYAS

Department of Microbiology, Haryana Agricultural University, Hissar, Haryana

SINCE Beijerinck[1] (1901) discovered the aerobic nitrogen-fixing bacterium called *Azotobacter*, a large number of carbon sources have been reported to serve as the energy source and building blocks for the species[2-5] (Skinner,[2] Bryan,[3] Fedrov[4] and Jensen[5]). This communication reports results of an investigation designed to find out which of the several carbon sources serve as efficient substrates for the isolation of *Azotobacter* and other species of aerobic nitrogen-fixing bacteria from saline alkali soils.

A wide variety of carbon sources as formate, acetate, succinate, citrate, benzoate, salicylate, alcohol, mannitol, sorbitol, glucose and sucrose were tested for their suitability for the enrichment of the aerobic nitrogen-fixing species. The saline alkali soils used as inocula in these experiments were obtained from the soil-testing laboratories of the Punjab Agricultural University. Some were also collected from the Regional Agricultural Station, Gurgaon, Haryana. The soil samples were stored at room temperature (30° C) in glass bottles prior to examination, which was done wherever possible soon after collection and storage.

Ashby's medium,[6] suitably modified with the substitution of the various carbon sources listed above, was used in this study as it proved to be efficient in most experiments conducted with normal soils. The pH of the medium was maintained at 7·0 for all the soils and irrespective of their pH except in few cases when the mannitol medium pH was adjusted correspondingly to the soils used as inocula with a view to see if the pH adjustments of the medium could lead to different results.

Enrichments in 100 ml of the liquid medium with various carbon sources were set in 250 ml. Erlenmeyers flasks inoculated with different soils of pH ranging from 8·0 to as high as 11·2 on a rotary shaker (28° C) for 3-4 days. A loopful of the liquid enrichments was streaked on the corresponding solid medium after 2-3 successive transfers were made through the liquid medium. By repeated streaking on the solid medium pure cultures of the isolates were made. These were subsequently maintained on Ashby's mannitol agar slants.

In as much as sucrose has been reported to be the most suitable source for the enrichment of *Azotobacter* by Darzniek[7] and Babak,[8] a comparison of the results was considered desirable to be made with sucrose on one hand and mannitol on the other.

The cultures were identified by the procedures detailed in the *Bergy's Manual*[9] and the capacity of each of the cultures to fix nitrogen was estimated using uniformly mannitol as the carbon source. The initial and residual mannitol in the cultures before and after growth was determined by Burton's[10] procedure (Table III).

TABLE I

Relationship between the enrichment of aerobic nitrogen-fixing bacteria and the carbon source

Carbon source	pH of the soil sample			pH of th enrichment medium
	8·0	9·0	9·8	
Formate ..	—	—	—	7·0
Acetate ..	—	—	—	7·0
Succinate ..	—	*	*	7·0
Citrate ..	—	*	*	7·0
Benzoate ..	—	—	*	7·0
Salicylate ..	—	*	—	7·0
Alcohol ..	*A. chroococcum*	—	*A. chroococcum*	7·0
Mannitol ..	*	—	*Derxia* sp.	7·0
,, ..	*	*	do.	9·8
Sorbitol ..	*	—	*A. chroococcum*	7·0
Glucose ..	*	*A. chroococcum*	do.	7·0

* = Represents unidentified.
— = not enriched.

From the results reported in Table I, it is clear that only alcohol, mannitol, sorbitol and glucose serve as suitable sources for the enrichment of both *Azotobacter* and *Derxia* species. Whereas nine species of *Azotobacter chroococcum* could be isolated from saline alkali soils, only two strains of *Derxia* appeared; interestingly, as many as 22 other bacteria also grew in the nitrogen-deficient medium but in as much as none of them were found capable of fixing nitrogen, they are not considered important in this connection and were not as such taken for identification.

It is interesting to observe that in one soil of pH 9·0 glucose succeeded in enriching the

Azotobacter species whereas alcohol failed to do so. Equally interesting was the observation that only from one soil that sorbitol could seek out the nitrogen fixer. Mannitol, on the other hand, not only brought out both the *Derxia* species, but proved to be superior to sucrose in the enrichments of *Azotobacter* as well (Table II). Curiously, sucrose provided better enrichment conditions for the isolation of a solitary species of *Azotobacter* from a highly alkaline soil of pH 10·2.

TABLE II

Effect of sucrose and mannitol on the enrichment of aerobic nitrogen-fixing bacteria

Carbon source		pH of the soil	Isolate	pH of the enrichment medium
Sucrose	..	8·6	*	7·0
,,	..	8·9	*	7·0
,,	..	9·5	*	7·0
,,	..	9·8	*	7·0
,,	..	10·2	*A. chroococcum*	7·0
,,	..	11·1	*	7·0
,,	..	11·2	*	7·0
Mannitol	..	9·7	*A. chroococcum*	7·0
,,	..	9·4	,,	7·0
,,	..	9·6	*	7·0
,,	..	9·8	*	7·0
,,	..	9·8	*A. chroococcum*	7·0
,,	..	9·8	*	7·0

* = Represents unidentified.

TABLE III

Nitrogen-fixing abilities of different isolates at their optimum pH for growth in Ashby's mannitol medium at 28° C

Sl. No.	Name of the organism		pH (optimum)	Nitrogen fixed (mg)	Residual sugar (mg)
1	*Derxia* sp.	..	8·0	8·4	0
2	,,	..	8·0	12·5	0
3	*A. chroococcum*	..	8·0	2·8	63
4	,,	..	8·0	4·2	27
5	,,	..	8·0	5·6	45
6	,,	..	8·0	4·2	27
7	,,	..	8·0	5·6	9
8	,,	..	7·0	4·2	0
9	,,	..	8·0	3·5	36
10	,,	..	8·0	4·2	45
11	,,	..	8·0	5·6	18

Derxia represents an interesting genus of nitrogen-fixing bacteria. Jensen *et al.*[11] reported on the nitrogen-fixing capacity of *D. gummosa* from West Bengal soils of pH 6·5. Its isolation from any other soils has not been so far reported. The organism isolated by the authors resembles *D. gummosa* in every respect except that it has not only a higher optimum pH (Fig. 1) but has a wider vigorous growth range of pH 6 to 10 as compared to that of the former which ranges from 5·5 to 9·0. Both the *Derxia* species reported here could fix appreciable amounts of nitrogen at their optimum pH of 8·0. It needs to be pointed in this connection that the very same species got enriched when the mannitol medium was adjusted at pH 7·0 or 9·8, the pH of the soil wherefrom the strains were isolated.

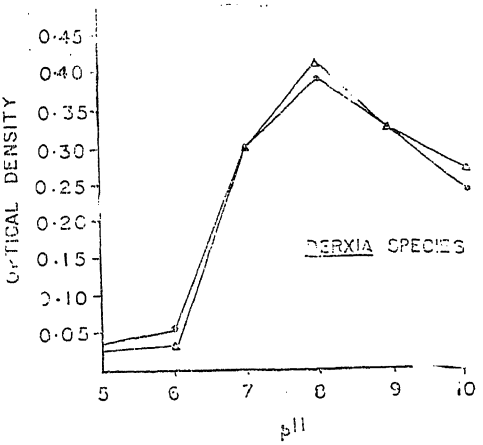


FIG. 1. Effect of pH on the growth of various isolates of *Derxia* species.

To conclude, it may be stated that both *Azotobacter* and *Derxia* species seem to thrive in saline alkali soils and mannitol appears to be the substrate of choice for their enrichments. It may be desirable to have the mannitol broths adjusted to neutrality and/or corresponding to the pH of the soils selected for isolation.

ACKNOWLEDGEMENTS

The authors are thankful to Prof. J. V. Bhat of Indian Institute of Science, Bangalore, for critically going through the manuscript.

1. Beijerinck, M. W., *Zentr. f. Bakt.*, *II Abt.*, 1901, **7**, 567.
2. Skinner, C. E., *Soil. Sci.*, 1929, **27**, 245.
3. Bryan, C. S., *Soil Sci.*, 1937, **45**, 185.
4. Fedrov, M. V., *Biologicheskya Fikatsiya Azota Atmosfery Selkhozgiz*, *Moskova*, 1952.
5. Jensen, H. L., *Bacteriol. Rev.*, 1954, **18**, 195.
6. Ashby, S. F., *J. Agr. Sci.*, 1907. **2**, 35.
7. Darzniek, Y. O., *Mikrobiologiya*, 1959, **28**, (3), 374.
8. Babak, N. M., *Ibid.*, 1965, **34**, 868.
9. Breed, R. S., Murray, E. G. D. and Smith, N. R., *Bergey's Manual of Determinative Bacteriology*, Seventh Edition, Williams and Wilkins Company, Baltimore, 1957.
10. Burton, R. M., *Methods in Enzymology*, Volume III, ed. by Colowick, S. P. and Kaplan, N. O., Academic Press, Inc., New York, 1957, pp. 246.
11. Jensen, H. L., Petersen, E. J., De, P. K. and Bhattacharya, R., *Archiv fu Mikrobiologie*, **36**, 182.

PRIMITIVE AND CURRENT CULTIVARS OF RICE IN ASSAM--A RICH SOURCE OF VALUABLE GENES

S. D. SHARMA, J. M. R. VELLANKI, K. L. HAKIM AND R. K. SINGH

Indian Agricultural Research Institute, Regional Research Station, Rajendranagar, Hyderabad-30

I. INTRODUCTION

FOR the following reasons, Drs. S. V. S. Shastry and M. S. Swaminathan proposed in 1965 a PL-480 project for the systematic collection of current and primitive cultivars of rice from the north-east parts of India. First, no systematic effort has been made to collect the local rice varieties from this region in the past. Secondly, from the point of view of origin of cultivated rices, this region occupies a pivotal position. Thirdly, people inhabiting this region, being of different ethnic origins, might have operated different selection pressures on the wild population. Fourthly, difficulties of terrain and inter-tribal rivalries might have acted as isolating mechanisms and helped to preserve enormous diversity. Lastly, a very wide variation in altitude and climatic conditions occurring in this region provide an array of ecological niches.

Geographically, north-east India comprises the eastern range of Himalayas and the valleys of Brahmaputra and Surma rivers. It ranges from 22° N to 30° N latitude. The elevation from sea-level is from 150 m to 1,500 m. The rainfall ranges from about 1,000 m to 5,000 mm. Politically, this region comprises of Assam, Meghalaya, Nagaland, Manipur and Tripura States of Indian Union as well as the North-East Frontier Agency (NEFA) of Assam State.

North-east India is inhabited by people of various ethnic groups speaking different languages. In the pre-historic time there have been immigrations from Tibet, China, Indo-China and peninsular India. In the historic past there have been immigrations from Thailand, Burma and Indian plains into this region. These people have introduced and preserved rice varieties of diverse characters. Cultivation of rice in the hilly regions is relatively primitive; shifting cultivation, locally known as "jhuming", being widely adopted. After clearing the forest and burning the refuse, rice is dibbled and grown entirely as a rainfed crop. After two or three years, the area is abandoned and a new area is cleared for cultivation. Tribal habits and superstitions have preserved a wide diversity in germplasm.

The progressive improvement in communication, education and economic condition of these people is, however, fast changing the agricultural scene in this area.

II. COLLECTION

The hill areas were given priority in the collection programme since hardly any collection appears to have been made from these areas in the past. The mode of collection differed according to terrain, communication, tribal customs, local seasons, as well as according to time and funds available. For example, it was possible to make a comprehensive collection in the plains directly by the collecting team because of approachable roads and co-operation from the people. In the hills, the collection was often indirect through local officials because of communication difficulties and tribal suspicions.

During the collection programme a sample of 100 g seed was collected for each variety (mostly from the farmers' stores). The duplication of varieties was, as far as possible, avoided within a block (a *block* refers to a sub-unit of district delimited for agricultural and community development activities). Information on the local name of the variety, the locality where it is grown, duration of crop, type of cultivation and type of land was collected for each variety.

Local types of rice have been collected from Meghalaya, Nagaland, NEFA and parts of Assam State. A total of 4,830 varieties have been collected so far (Table I). Eliminating the probable duplicates, the total collection may come to about 4,000 only. In general, the number of varieties grown in any particular area is far higher in the plains than in the hills. Since collections are still to be made in Manipur, Tripura, Mizo Hills and some plain districts of Assam, the total number of varieties locally grown in this whole region may be anywhere between 5,000 and 8,000.

III. EVALUATION

The material collected was grown at the Regional Research Station of IARI, Hyderabad and IARI, New Delhi, and studied for its botanical and agronomic traits. At Delhi, studies

TABLE I

Number of cultivars collected from different districts of Assam, NEFA, Meghalaya and Nagaland

State	District	No. of collections	Total
Assam (Plains)	North Lakhimpur	537	
	Sibsagar	29	
	Kamrup	231	
	Goalpara	27	
	Research Station (Titabar)	182	1,006
Assam (Hills)	Mikir Hills	170	
	North Cachar Hills	74	244
NEFA	Kameng	138	
	Subansiri	383	
	Siang	330	
	Lohit	374	
	Tirap	202	1,527
Meghalaya	Garo Hills	784	
	Khasi and Jaintia Hills	547	
	Research Station (Shillong)	41	1,372
Nagaland	Tuensang	260	
	Mokokchung	256	
	Kohima	165	681
			4,830

were also conducted on protein content, amylose percentage and D-Mannitol test for drought resistance, while the All-India Coordinated Rice Improvement Project carried out screening for resistance to disease and pests. A few of the interesting features of this collection are summarised below:

(*a*) *Plant Type*.—A majority of the collections from north-east India have tall and leafy plant type as generally seen in local Indian types. However, a few of them were short-statured (height: 70–105 cm) with dark green and erect or semi-erect leaves and good plant type. In total 86 cultivars with thin plant type have been identified. It is noteworthy that most of them are from hill regions. The genetic behaviour as well as the yielding ability of these types are being investigated.

(*b*) *Japonica Types*.—The collections from higher elevations of NEFA resemble *japonica* types (when grown under tropical conditions at Hyderabad) in many characters: the plant height, culm thickness, temperature sensitivity, leaf colour, panicle characters, hairiness of lemma and palea, grain size, etc. The amylose content, phenol reaction, alkali digestion, etc., as carried out in a few collections as the Genetics Division of IARI also indicate the *japonica* nature of some collections. Detailed investigations of these collections are being undertaken. It should be remarked that according to some Japanese authors (Morinaga and Kuriyama, 1955; Kihara, 1968), the differentiation of *japonica* types took place in Himalayan region of Asia and these types were subsequently introduced to Japan.

(*c*) *Glabrous Types*.—The glabrous nature of the leaf and husk is a rare character in the Indian cultivars of *O. sativa*. This character is met with in the improved types of U.S.A. and Surinam. The presence of many glabrous types is an important aspect of these collections. This character has been reported earlier from NEFA, Nagaland and Manipur (Richharia and Govindaswamy, 1960; Kulkarni, 1962; Krishnamurty, Ved Prakash and Sharma, 1967). According to Sampath and Seshu (1958), this character is met with in the Philippines collections also and has been incorporated into American types.

(*d*) *Glutinous Types*.—The glutinous types of rice are generally not grown in India outside Assam. Even in Assam, these are generally found in upper Assam. It would be worth investigating if these are early introductions from Thailand or Burma by Tai-Ahoms.

(*e*) *Other Morphological Characters*.—Several other agro-botanical traits such as tiller number, panicle length, number of grains per panicle, grain size, total duration, etc., were recorded. Many of the local collections appear to be good donors for these characters in any breeding programme.

(*f*) *Drought Resistance*.—A part of the material has been screened for drought resistance. The field testings were done at the Regional Research Station, Hyderabad, and the laboratory test for germination in D-mannitol solution were conducted at the Genetics Division of IARI. It appears that many of these collections are promising as drought resistant types and a few of them have given good yields as well (Table II).

(*g*) *Protein and Amylose Content*.—The protein and amylose content of some of these collections has been analysed at the Division of Genetics (IARI). The protein content of these rice collections varies from 6% to 14%. In about 300 collections tested, 20 types have protein content more than 10%. These collections also differ for the distribution of protein in their endosperm. The types with higher protein content distributed in the deeper layers are

TABLE II

Assam rice collections screened for resistance to certain diseases, pests and physiolcgical conditions

Tested for		No. of collections tested	No. of collections suspected to be resistant	Tested by
Blast	..	832	25	AICRIP
Helminthosporium		618	1	,,
Bacterial leaf blight (A)		1,363	24	,,
,, (B)		700	51	IARI (Delhi)
Rice "Tungro" virus		130	22	AICRIP
Gall midge	..	1,261	44	,,
Stem borer	..	1 348	91	,,
Drought (A)	..	3,692	105	IARI (Hyderabad)
,, (B)	..	50	10	IARI (Delhi)

IARI (Delhi) : Indian Agricultural Research Institute, New Delhi.
IARI (Hyderabad) : Indian Agricultural Research Institute, Regional Research Station, (Hyderabad).
AICRIP : All - India Co-ordinated Rice Improvement Project.

desirable from breeding point of view. The amylose content of these collections varies from 0% to 29·5%. Almost all intermediate values were obtained for this character.

(k) *Disease and Pest Resistance.*—The collections are being tested for the resistance to disease and pests. Up till now, a good number of collections have been screened for resistance to gall midge, stem-borer *Helminthosporium*, blast. bacterial leaf blight and rice tungro virus. Although the results are tentative and need further confirmation. it appears that these collections are promising as new sources of resistance (Table II).

IV. BREEDING VALUE

Although the collection and assessment of the material is still in progress, the available data indicate that local types of Assam provide a rich source of genetic diversity and offer excellent promise for future breeding programmes. The dwarf plant type, glabrous husk. glutinous kernel. high protein content and resistance to important diseases and pests will prove very valuable in future breeding programmes. In view of the presence of *japonica* plant type in this region, the scope and limitations of *japonica-indica* hybridization programme might be reassessed. The material is also being tested for cold tolerance, saline resistance, resistant to grassy stunt virus, etc., and resistance if found for any of these will further enhance the importance of these materials. One of the wild rice (*O. nivara*) collection has been reported by the International Rice Research Institute, Los Banos, Philippines, to be resistant to grassy stunt virus. Incidentally, this is the only known source of resistance to this virus reported so far.

ACKNOWLEDGEMENT

We express our sincere gratitude to Dr. M. S. Swaminathan, Director, Indian Agricultural Research Institute, New Delhi-12, and to Dr. S. V. S. Shastry, Project Co-ordinator, All-India Co-ordinated Rice Improvement Project, Hyderabed-30, for their guidance and assistance. We are also grateful to Dr. L. G. Kulkarni and Dr. N. Ganga Prasada Rao, former and present Heads of the Regional Research Station, IARI, Hyderabad, for providing facilities for this work. The assessment work at Delhi is being carried out by Drs. E. A. Siddiq and A. K. Kaul, to whom our thanks are due for active co-operation. Thanks are also due to Dr. W. H. Freeman, Joint Co-ordinator, All-India Co-ordinated Rice Improvement Project, Hyderabad; Dr. D. N. Borthakur, Director of Research, Assam Agricultural University, Jorhat; Mr. M. C. Joshi, Joint-Director of Agriculture, NEFA Administration, Shillong; Mr. I. Panger Ao, Director of Agriculture, Kohima, Nagaland, and their staff for actively participating in the collection programme. The collection was rendered possible through a PL-480 grant by the United States Department of Agriculture.

---

1. Kihara, H., "History of biological and other sciences in Japan in retrospect," *Proc. XII Int. Cong. Gen*, 1968, **3**, 49.
2. Krishnamurty, A., Ved Prakash and Sharma, A. C., "Glabrous varieties of cultivated rice (*O. sativa*) in Manipur," *Oryza*, 1967, **4** (1), 74.
3. Kulkarni, V. A., "Studies on some rice varieties from Naga Hills Tuensang area, Sikkim and Nepal," *Rice News Teller*, 1962, **10** (1), 22.
4. Morinaga, T. and Kuriyama, H, "*Japonica* type rice in the sub-continent of India and Java," *Jap. Jour. Breeding*, 1955, **5**, 149.
5. Richharia, R. H. and Govindaswami, S., "Glabrousness in cultivated rice," *Rice News Teller*, 1960, **8** (4), 5.
6. Sampath, S. and Seshu, D. V., "Glabrousness in rice," *Ibid*, 1968, **6** (2), 13.

LETTERS TO THE EDITOR

L SHELL PHOTOELECTRIC CROSS-SECTIONS FOR LOW ENERGY GAMMA RAYS IN LEAD

[illegible] the L shell [illegible] Gamma rays of energies 84, 145 and 279 keV [illegible] were estimated on a thin lead target [illegible] calibrated proportional counter. Using the [illegible] L-shell photoelectric cross-sections for lead were determined [illegible] The experimental details [illegible] The errors quoted are [illegible] statistics of the measurements [illegible] in the [illegible] measurement. [illegible] also contribute to the [illegible] Its contribution should be subtracted before a comparison is made with theoretical predictions. The probability of secondary ionization of L shell by photoelectrons is [illegible] and can be safely neglected considering the uncertainties present in the measurements. The results are shown in Table I.

TABLE I

Energy in keV	Experimental value	Schmickley Pratt	Matese Johnson	Alling-Johnson
84	479·4 ± 40	462	499	560
145	106·5 ± 13·9	103	113	127
279	16·3 ± 2·1	17·2	17·97	20·41

Our results contradict Alling-Johnson values showing that the screening effects for L-shell are quite significant, hence cannot be neglected.

Punjabi University, Patiala, *December* 7, 1970.

MOHANJIT SINGH.
B. S. SOOD.

1. Alling, W. R. and Johnson, W. R., *Phys. Rev.*, 1965, **139 A**, 1050.
2. Matese, J. J. and Johnson, W. R., *Ibid.*, 1965, **140 A**, 1.
3. Rakavy, G. and Ron, A., *Ibid.*, 1967, **159**, 50.
4. Schmickley, R. D. and Pratt, R. H., *Ibid.*, 1967, **164**, 104.
5. Brysk, H. and Zerby, C. D., *Ibid.*, 1968, **171**, 292.
6. Marty, N., *J. Phys. Radium*, 1952, **12**, 401.
7. Grigorev, E. P. and Zolotavin, A. V., *Soviet Phys. JETP*, 1959, **9**, 272.
8. Sujkowski, Z., *Arkiv. F. Fysik*, 1961, **20**, 269.
9. Carlsson, E., Fahlman, A. and Siegbahn, K., *Ibid.*, 1966, **36**, 103.
10. Boyd, H. W. and Hamilton, J. H., *Nuovo Cimento*, 1965, **79** (1), 1.
11. Parthasaradhi, K., *Nucl. Inst. and Methods*, 1970, **81**, 205.
12. Hall, H., *Z. Physik.*, 1934, **91**, 633.
13. Ghumman, B. S., Anand, S. and Sood, B. S., *Indian J. of Pure Appl. Phys.*, 1967, **5**, 70.
14. Oberoi, R. S., Bal Mohan and Sood, B. S., *Curr. Sci.*, 1965, **34**, 372.
15. Wu, C. S., *Phys. Rev.*, 1954, **93**, 518.

A METHOD OF ASSIGNING THE VIBRATION BANDS BY PROGRESSIVE ISOTOPE EXCHANGE

Assignment and nature of the amide bands in infra-red spectra of amides has been discussed by various workers.[1-5] Hadzi and co-workers[6] have studied the infrared spectra of alkyl and aryl hydroxamic acid and have proposed the assignment of some bands. A new method based on differential rate of hydrogenation of assigning the bands is proposed in the present study. This is applied to benzohydroxamic acid which has CO NH OH grouping resulting in modification of some assignments;

Benzohydroxamic acid was deuterated by repeated exchange with heavy water. Progressive rehydrogenation was done by exposing samples to controlled atmosphere with 60% R.H. for various periods. Spectra were recorded in KBr pallet. All operations were done in a dry box in nitrogen atmosphere. Typical spectra are reproduced in Fig. 1. The relative intensities of the bands were measured by using the carbonyl band at 1650 cm^{-1} as internal standard. This band was found to be insensitive to deuteration. The comparison is made of the ratios of the intensity of the band to the band at 1650 cm^{-1}. These are plotted in Figs. 2 and 3.

Hazdi *et al.* have observed three bands in 3 μ region in all hydroxamic acid. These bands in benzohydroxamic acid according to previous workers as also according to present work are at 3340, 3080 and 2770 cm^{-1}. Since at high temperature in CCl_4 solution, a sharp band at 3450 cm^{-1} develops and 3340 cm^{-1} disappears, the new band is assigned to monomeric NH stretching whose frequency falls to 3340 on intermolecular bonding. Since monomeric OH stretching band is not observed even at high temperature, it is strongly intramolecularly bonded and the band at 3080 cm^{-1} is assigned to OH stretching. The third bond at 2770 cm^{-1} is assigned to OH by previous workers, but it is shown to be due to NH from the following considerations.

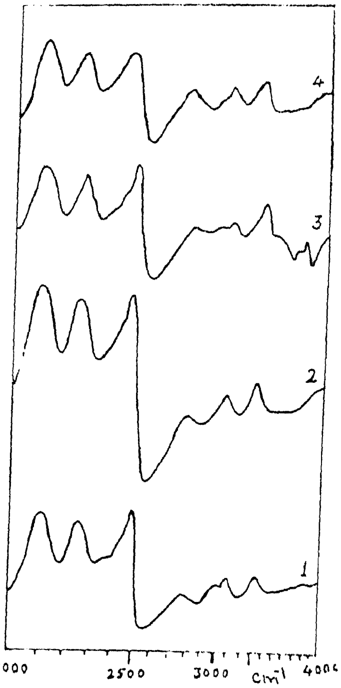


FIG. 1. Infra-red spectra of benzohydroxamic acid (1) deuterated sample and rehydrogenated sample exposed for (2) 20 min., (3) 2 hrs. and (4) 7½ hours.

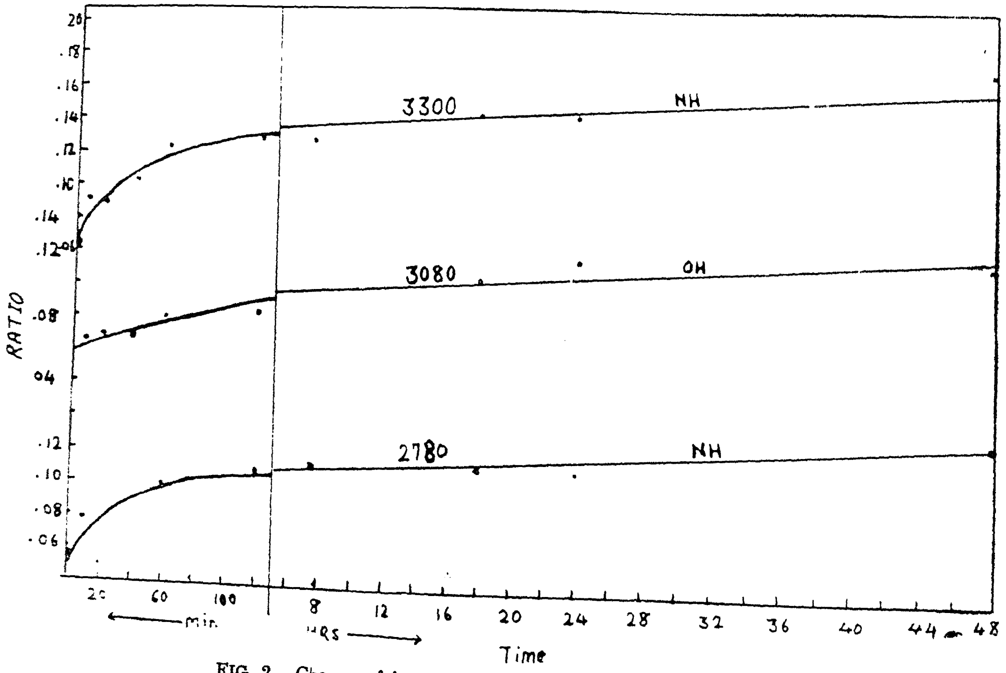


FIG. 2. Change of intensity of bands in proton region.

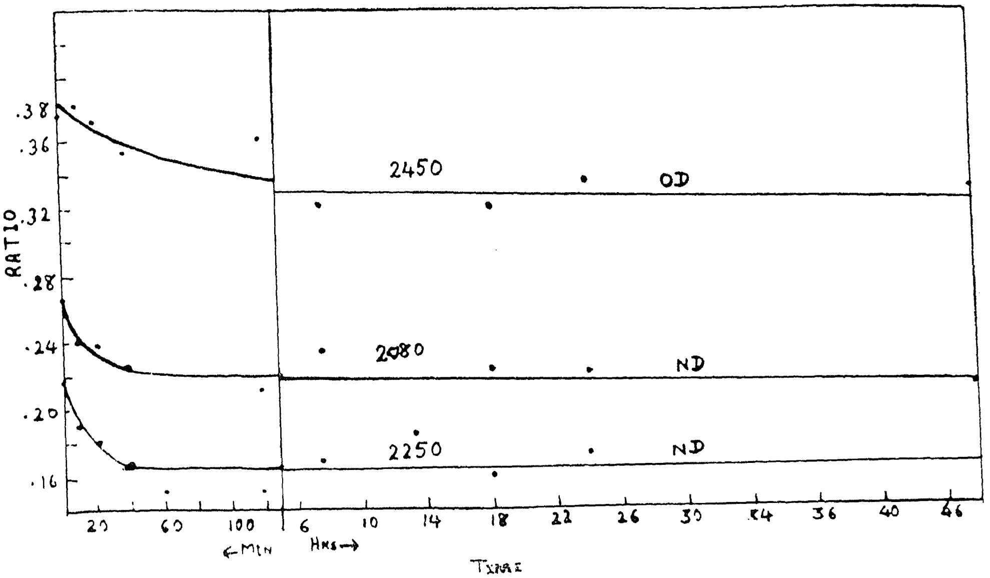


FIG. 3. Change of intensity of bands in deuterium region.

In completely deuterated benzohydroxamic acid, three bands are observed in ND, OD stretching region at 2450, 2250 and 2080 cm^{-1}. During rehydrogenation, these bands lose intensity and bands in proton region gain intensity, the rate of gain or loss of intensity being a measure of the rate of rehydrogenation of the group responsible for the band. In the present case, it is observed that there are two types of curves specifically in initial position both when the loss of intensity of one set of bands and gain of intensity in another set of bands is plotted. The bands 3340 and 2770 cm^{-1} show a faster rise and 2080 and 2250 cm^{-1} faster fall of intensity than the bands 3080 and 2450 cm^{-1} respectively. This shows that rates of rehydrogenation are different for the ND and OD groups and that 3340 and 2770 cm^{-1} bands arise from one group and 3080 cm^{-1} from the other group. Since 3340 cm^{-1} is assigned to NH from independent evidence, the first two bands are assigned to NH and the band at 3080 cm^{-1} to OH group. This method could be applied since there is a measurable difference in the rate of rehydrogenation of the two groups. A similar study of other bands affected by deuteration does not show a marked difference possibly because these involve mixed vibrations.

Dept. of Chem. Tech., M. R. PADHYE.
University of Bombay, R. R. KARNIK.
Bombay, *December* 14, 1970.

---

1. Miyazawa, T., Shimanouch, T. and Mizushima, S., *J. Chem. Phys.*, 1956, **24**, 408.
2. —, — and —, *Ibid.*, 1958, **29**, 611.
3. Suzuki, I., *Bull. Chem. Soc. Japan*, 1960, **33**, 1359.
4. —, *Ibid.*, 1962, **35**, 540, 1279.
5. Rao, C. N. R., *Chemical Applications of Infrared Spectroscopy*, Academic Press, New York, N.Y., 1963,
6. Hadzi. D. and Prevorsek, D., *Spectrochim. Acta*, 1957, **10**, 38.

MULTIPLE PRODUCTION OF ANTIBIOTICS : DISTRIBUTION PATTERN

DIFFERENT species of micro-organisms and variants of one and the same organism may produce, depending upon the cultural conditions, antibiotics similar in their chemical and biological properties. On the other hand, one and the same micro-organism may produce antibiotics differing in their chemical and biological properties, again depending upon the cultural conditions.[1] This may result in the rediscovery of one and the same antibiotic from different sources. A modified Poisson distribution has been shown to be a good fit for the frequency of such rediscoveries.[2] In the present note, we show that the modified Poisson distribution is a good fit for the pattern of multiple production of antibiotics by two groups of micro-organisms : (1) Actinomycetales ; and (2) Algae, fungi and lichen,

TABLE I

Data on the multiple production of antibiotics

Number of antibiotics over and above one	Number of organisms producing one or more antibiotics			
	Actinomycetales		Algae, lichen, fungi	
	Observed	Expected	Observed	Expected
0	706	708·86	246	242·63
1	66	65·40	33	36·18
2	29	26·12	12	14·52
3	13	13 06	9	7·04
4	7	7·24	3	3·71
5	5	5·16	1	2·04
6	2	3·08	3	1·17
7	1	1·91	2	0·68
8	2	1·16		
9	0	0·75		
10	1	0·50		
	χ^2 at 5%	Calc 3·091 Table[5] 18·31	χ^2 at 5%	Calc 7·319 Table[5] 14·07

The source of data on the report of production of antibiotics by various micro-organisms is a compilation by Rao and others.[3] In the modified Poisson distribution[4] used here, the *pdf* is given by:

$$\left(\frac{c}{c+1}\right)^{p} \frac{p\,(p+1)\,(p+2)\,\cdots\,\{p+(r-1)\}}{(r-1)!\,(c+1)^{r}} \qquad (1)$$

where p and c are constants to be estimated using the following relations:

$$\text{Mean of } X = p/c \qquad (2)$$

$$\text{Var}(X) = p/c + p/c^2. \qquad (3)$$

Using (2) and (3), p and c were separately estimated from the data on antibiotics production by the two groups of organism. Using (1), the expected frequencies were computed. A χ^2 goodness of fit was done. For the purpose of fitting the distribution, the upper tail of the distribution from frequency 11 and above for the Actinomycetales group and from frequency 8 and above for the algae, fungi, and lichen group were omitted. Table I gives the details of the goodness of fit. In the data given here, a variant or mutant is taken as a distinct organism.

In the case of both the groups of micro-organisms, the goodness of fit of the modified Poisson distribution was confirmed. Thus, a pattern of distribution is seen in the frequency of multiple production of antibiotics by the micro-organisms considered. The modified Poisson distribution was found to be a good fit even if a mutant was not taken as a separate organism. However, Dr. K. S. Gopalakrishnan, Chief Mycologist, Hindustan Antibiotics Ltd., Pimpri, has suggested (in a letter to A. Neelameghan) that the kind of data presented in Table I would be of greater interest and value.

Documentation Res. and
Training Centre,
Indian Statistical Institute,
112, Cross Road 11,
Malleswaram, Bangalore-3,
December 17, 1970.

A. NEELAMEGHAN.
B. S. S. GUPTA.

---

1. Neelameghan, A., "Discovery, duplication, and documentation: A case study," *Library Science*, 1968, **5**, 264.
2. —, Buche, V. V. and Gupta, B. S. S., "Distribution pattern of the duplication of discoveries," *Nature*, 1970, **227**, 1060.
3. Rao, G. S., Bannur, B. B. and Purandare, G. M., "Index to antibiotics producing micro-organisms," *Hindustan Antibiotics Bulletin*, August 1967, **10** (1), 1.
4. Kendall, M. G. and Stuart, A., *Advanced Theory of Statistics*, 2nd edition, Hafner Publishing Co., New York, N.Y., 1958, **6**.
5. Rao, C. R., Mitra, S K. and Matthai, A., *Formulae and Tables for Statistical Work*, Statistical Publishing Society, Calcutta, 1966.

EFFECT OF 8-AZAGUANINE ON RIBONUCLEASE ACTIVITY OF *PHASEOLUS RADIATUS* SEEDLINGS

A MARKED inhibition of growth, as well as of synthesis of some enzymes like β-amylase, phosphatase and RNase, was observed with 8-azaguanine in germinating *Phaseolus radiatus* seedlings.[1] This prompted a study of the effect of 8-azaguanine (8-AzaG) on the nucleic acids of the seedlings, RNA in particular, as it was the most probable site of inhibitory action of the antimetabolite. In the present investigation, the effect of 8-azaguanine treatment was explored on the nature of ribonuclease action on total RNA of the seedlings.

A set of 20 *Phaseolus radiatus* seeds grown for 3 days with or without 1 mg 8-AzaG, were homogenised at 0-4° C with water to 30 ml and centrifuged at 3,000 RPM for 20 min. The supernatant was used for assaying the RNase activity. RNA was isolated from the 3-day seedlings by the method of Lane and Allen.[2] RNase activity was assayed in a total volume of 2 ml containing 1 ml 0·1% RNA solution, prepared in 0·1 M acetate buffer, pH 5·0 and 1 ml enzyme extract, incubated at 29° C for 60 min. After adding MacFayden's reagent,[3] the centrifugate of each tube was analysed for total phosphate.[4] Observations are summarised in Table I.

TABLE I*

Enzyme source	RNase units per 20 seedlings with the substrate		
	Yeast RNA	RNA from normal seedlings	RNA from treated seedlings
Control ..	252 (50)	504 (100)	144 (28)
8-azaguanine treated	36 (7)	216 (42	88 (17·5)

* One unit was defined as the activity which liberates 1 mg of soluble phosphorus under the experimental conditions. Figures in parentheses represent relative activities when compared to the activity of RNase from normal seedlings on RNA from the same source taken as 100.

The activity of the two nucleic acid preparations to act as substrates for the enzymes isolated from normal and 8-AzaG-treated seeds was found to be markedly different. The extent of hydrolysis by the enzyme from 8-AzaG-treated seedlings was 42% of that of the control enzyme when normal seedling RNA was the substrate, 61% with 8-AzaG-treated seedling RNA as substrate and only 14% using yeast RNA (Schwartz lab.) as the substrate. This indicated that not only there was an inhibition of the synthesis of the enzyme during germination which is known to increase in 3 days by about 25% in normal germinating seeds, but that the nature of the enzyme synthesized and also of the RNA in the two types of seedlings was radically different. Thus, the enzyme from controlled seedlings could hydrolyse the RNA from treated seedlings only to an extent of 28%. Even the enzyme from the 8-AzaG-treated plants could act on the normal RNA with a much better facility than on the treated RNA, the relative action on the latter being about 40%.

8-Azaguanine is known to be incorporated to a large extent into RNA[5] but the extent of incorporation into DNA appears to be meagre.[6,7] The present observations suggest that the 8-azaguanine treatment not only served to alter the nature of RNA in the seedlings but the nature of RNase also changed significantly. During germination, although the total RNA content declines, new RNA is synthesised to a significant extent.[1] Obviously, this new RNA is so altered structurally that the phospho-di-ester bonds are not readily accessible to the enzyme. Such an altered RNA, *m*RNA in particular[8] would perhaps be responsible for considerable disorganisation of normal protein synthesis. Thus, it has been observed that poly UAzaG did not stimulate incorporation of ^{14}C valine into polypeptides as efficiently as poly U-G in *E. coli* cell-free system.[9,10] Inhibition of protein synthesis by 8-AzaG due to differences in template efficiency of codons containing 8-azaguanine of guanine during protein synthesis has also been observed in *B. cereus*.[11]

Bombay University,
Dept. of Chem. Tech.,
Matunga, Bombay 19 DD,
December 5, 1970.

P. R. KULKARNI.
D. V. REGE.

---

1. Kini, C. V., Kulkarni, P. R. and Rege, D. V., *Proceedings of the Symposium on "Macromolecules in Storage and Transfer of Biological Information,"* held at Bhabha Atmomic Research Centere: Bombay, December, 1969, p. 447.
2. Lane. B. G. and Allen, F. W., *Biochem. Biophys. Acta*, 1961, **47,** 36.
3. MacFayden, D. A., *J. Biol. Chem.*, 1934, **107,** 297.
4. Umbreit, W. W., Burris, R. H. and Stauffer, J. H., *Manometric Techniques*, 1959, p. 273.
5. Smith, J. D. and Mathews, R. E F., *Biochem. J.*, 1957, **66,** 323.
6. Mitchell, J. H., Skipper. H. E. and Bennett, L. L., *Cancer Research* 1950, **10,** 647.
7. Mandel, H. G., Carlo, P. E. and Smith, P. K., *J. Biol. Chem.*, 1954, **206,** 181.
8. Chantrenne, H., *J. Cell. Comp Physiol.*, 1964, **64,** Suppl. 1, 149.
9. Gürnberger, D., O'Neal, C. and Nirenberg, M., *Biochim. Biophys. Acta*, 1966, **119,** 581.
10. —, Meissner, L., Holy, A. and Sorm, F., *Collection Czech. Chem. Commun.*, 1967, **32,** 2625.
11. —, "Ribonucleic acid structure and function," *Proceedings of the 2nd Meeting of the Federation of European Biochemical Societies*, Vienna, 1966. p. 19.

AN ELECTRONMICROSCOPIC STUDY ON THE ULTRASTRUCTURE OF THE PERITROPHIC MEMBRANE OF A CHILOPOD *ETHMOSTIGMUS SPINOSUS* TOGETHER WITH OBSERVATIONS ON ITS CHEMICAL COMPOSITION

IT is known that the midgut in all the arthropods is internally lined by a thin membrane, called the peritrophic membrane.[1-4] Investigations with electronmicroscope disclose that this membrane is fibrous and made of strands which run in various directions, delimiting smaller holes, whose shape is characteristic in different groups of arthropods[4-6]; the holes are hexagonal in shape in both crustaceans and arachnids reflecting their phylogenetic kinship[4]; in insects, on the other hand, the shape of the holes is circular.[5] In Onychophora and Diplopoda the holes are rectangular in shape[4,7] differing from the condition noted in insects. It will be of interest, in this context, to know whether or not the ultrastructure of the peritrophic membrane in Chilopoda is similar to that in Diplopoda and Onychophora to which this group is closely related.[8] In the work reported here, observations on the peritrophic membrane with electronmicroscope have been extended to a chilopod.

The material used was chilopods of the species *Ethmostigmus spinosus*. After starving for two days, the peritrophic membranes were isolated from different regions of the midgut by *et al.*,[9] and washed thoroughly in distilled-water. For electronmicroscopic study, the aqueous water. For electronmicrospic study, the aqueous suspension of the peritrophic membranes were taken onto formvar-coated glass screens and dried in air at 20-25° C. Such preparations were shadow-cast with palladium, as suggested by DeMets,[4] and examined with an R.C.A. EMU-2 electronmicroscope. The methods employed for chemical analyses of the peritrophic membrane are given in appropriate contexts.

Examinations under the electronmicroscope reveal that the peritrophic membrane of *Ethmostigmus spinosus* consists of a mat-like network consisting of two systems of transverse and longitudinal cords or strands, disposed in regular order at right angles, delimiting rectangular holes (Fig. 1). All the strands in the network are uniform in thickness measuring 6 to 10 millimicrons. In several places the parallel strands are frayed into fibrils of similar diameter of about 2 to 3 mμ, suggesting that the strands of the peritrophic membrane in their turn are made of smaller fibrils. The size of the holes in the peritrophic membrane varies in different region of the midgut; in the anterior one-third of the midgut, the holes are small, measuring 23 by 38 mμ; in the middle region of the midgut, the holes measure 36 by 49 mμ and in the posterior one-third they measure 46 by 58 mμ.

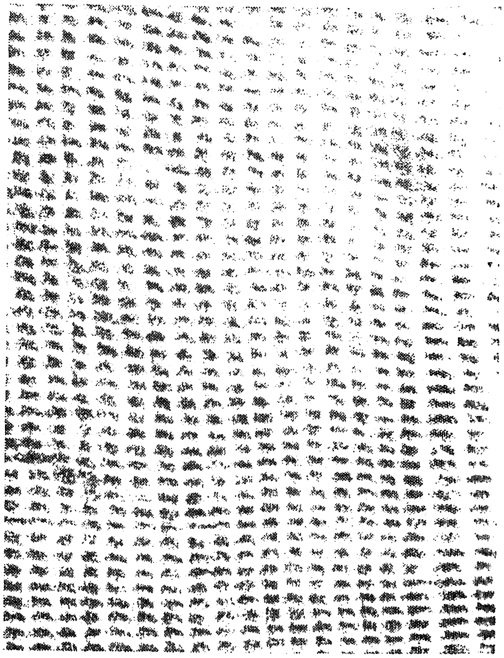


FIG. 1. A part of the peritrophic membrane from the middle region of the midgut of *Ethmostigmus spinosus*. Shadow cast with palladium, × 42,000.

It may be seen from the foregoing account that the peritrophic membrane of *Ethmostigmus spinosus* recalls that in the diplopod *Iulus albipes*[4] and the onychophore *Peripatus trinidadensis*[7] in having rectangular holes. This would substantiate the suggestion of Tiegs and Manton[8] that Onychophora, Diplopoda and Chilopoda are phylogenetically very closely related.

In view of the fact that very little is known of the chemical nature of the peritrophic membrane in diplopods and chilopods, the peritrophic membrane of *Ethmostigmus spinosus* was subjected to analyses for protein, lipid and carbohydrate.

Paper partition chromatographic analyses of the amino-acid constituents of the hydrolysate of the peritrophic membrane, by the method of Giri and Rao,[10] revealed the presence of [illegible] amino-acids (alanine, arginine, aspartic acid, glutamic acid, glycine, histidine, hydroxyproline, isoleucine, leucine, methionine, phenyl alanine, proline, serine, threonine, tyrosine and valine) suggesting the presence of a protein component. The membrane in question is negative to Sudan Black-B and Nile Blue tests, indicating the absence of lipid in it. An intensely positive chitosan reaction obtained on the peritrophic membrane denotes the presence of chitin.

The work of Sundara Rajulu[11,12] shows that in chilopods the secretions from the midgut epithelium contain powerful proteolytic enzymes and also a chitinase. Therefore, it is necessary that the peritrophic membrane should have some component to protect it from the action of these enzymes.

It is known from the work of Monne[13] that the intestinal parasites are protected from the hosts' enzymes by the acid mucopolysaccharides present on the surface of their body. Therefore, an attempt was made to find out if the peritrophic membrane in *Ethmostigmus spinosus* contains acid mucopolysaccharide.

The peritrophic membrane stained deeply blue with alcian blue and yielded γ-metachromasia with toluidine blue indicating the presence of highly acidic mucopolysaccharide.[14] The metachromasia was not removed by washing with 95% ethanol suggesting the presence of esters of sulphuric acid.[14] Methylene blue stained the membrane at pH 2·6 and the extinction point lies between pH 1·0 and 1·4. The capacity to bind methylene blue below pH 4·0 is considered indicative of presence of sulphated groups.[14] These observations may denote that the peritrophic membrane in *Ethmostigmus spinosus* contains sulphated acid mucopolysaccharide. In view of the observations of Monne,[13] it is suggested that the acid mucopolysaccharide in the peritrophic membrane in question may protect it from the digestive action of the enzymes from the midgut secretions.

An unsolved problem in insects is the nature of the component that may protect the peritrophic membrane from the midgut enzymes.[15] But no attempt has so far been made to look for the presence of acid mucopolysaccharides in the membrane. It will be interesting, in the light of the present observation, to find out if the peritrophic membrane in insects also has acid mucopolysaccharide to resist the action of midgut enzymes.

Part of this work was carried out in the Kotor Marine Biology Institute, Yugoslavia; I am thankful to the Director, Dr. V. P. Lepetic, for provision of facilities. I am grateful to the Smithsonian Institution, U.S.A., for financial support, and to Prof. G. Krishnan for helpful criticism.

Dept. of Zoology, G. SUNDARA RAJULU.
University of Madras,
Madras-5, *December* 8, 1970.

---

1. Manton, S. M. and Heatly, N. G., *Phil. Trans.* (B), 1937, **227**, 411.
2. Richards, A. G. and Anderson, T. F., *J. Morph.*, 1942, **71**, 135.
3. Huber, W., *Arch. Anat. Strastbourg*, 1950, **33**, 1.
4. DeMets, R., *Nature, Lond.*, 1962, **196**, 77.
5. Huber, W. and Haaser Ch., *Ibid., Lond.*, 1950, **165**, 397.
6. Mercer, E. H. and Day, M. F., *Biol. Bull.*, 1952, **103**, 384.
7. DeMets, R., Nayak, N. A. and Gregoire, Ch., *Proc. Nat. Inst. Sci. India*, 1963, **30**, 131.
8. Tiegs, O. W. and Manton, S. M., *Biol. Rev.*, 1958, **33**, 25.
9. Nisizawa, K., Yamaguchi, T., Handa, N., Meda, M. and Yamazaki, H., *J. Biochem.*, 1963, **54**, 419.
10. Giri, K. V. and Rao, N. A. N., *J. Ind. Inst. Sci.*, 1952, **34**, 95.
11. Sundara Rajulu, G., *Zool. Jb. Physiol.*, 1967, **73**, 276.
12. —, *J. Anim. Morph. Physiol.*, 1970, **17**, 35.
13. Monne, L., *Ark. Zool.*, 1959, **13**, 343.
14. Kramer, H. and Windrum, C. M., *J. Histochem. Cytochem.*, 1954, **2**, 196.
15. Day, M. F. and Waterhouse, D. F., *Insect Physiology*, John Wiley & Sons, Inc., New York, 1953, p. 289.

THE OCCURRENCE OF A CYST OF *SARCOSYSTIS LANKESTER*, 1882 IN THE CEREBRUM OF A GOAT

THE protozoan parasite of the genus *Sarcocystis* commonly infesting the striated muscles like heart, tongue, diaphragm, and oesophagial muscles, has been reported from all species of herbivorous animals. Sarcosporidia have also been reported from omnivorous mammals and reptiles. The parasite is often found incidentally during microscopical examination of *post-mortem* materials. Bigalke and Tustin[1] recorded this parasite in the cerebellum of an ox. The object of this note is to place on record its occurrence in the cerebrum of a goat.

On the routine microscopical examination of formalin fixed and haematoxylin-eosin stained sections of brain tissue collected from a goat which had died of pneumonia and enteritis, a single cyst was found in the grey matter of the cerebrum (Fig. 1). The cyst was oval or elliptical with a clearly demonstratable cyst-wall which remained unstained by haematoxylin-eosin stain. The cyst measured 148/74 µ in size, and contained within this cyst were spherical, ovoid and elliptical to typical banana-shaped spores with rounded ends. The spores were purple in colour with darkly-stained nuclei. The banana-shaped spores measured 10 μ to 12 μ in length and 3 μ to 4 μ in width.

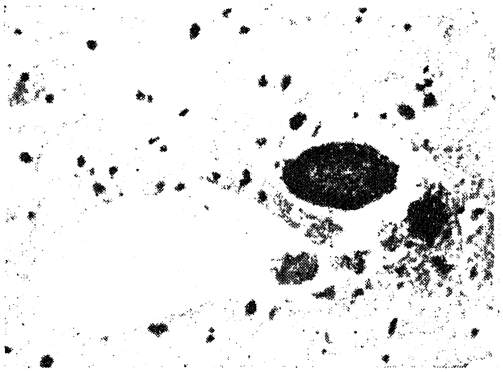


FIG. 1. Section of brain showing a cyst of *Sarcocystis* H & E, × 290.

It is interesting to note that no cellular reaction was present in the brain around the parasitic cyst (Fig. 1). It is generally known that the parasitic cyst does not always evoke any tissue reaction around them in striated muscles also.

The parasite in question in the brain was identified as a cyst of *Sarcocystis* on the basis of the size and shape of the cyst, nature of the cyst-wall, and morphology of the spores contained within the cyst from closely related organisms like *Besnoitia besnoiti* (Marotel, 1912), *Toxoplasma gondi* (Nicolle and Manceaux, 1909) and *Nosema cuniculi* (Levaditi, Nicolau and Schoen, 1924).

My thanks are due to Shri M. C. Tewari for the photomicrograph.

Division of Pathology, P. K. R. IYER.
Indian Vet. Res. Inst.,
Izatnagar, U.P., *September* 18, 1970.

---

1. Bigalke, R. D. and Tustin, R. C., *J. South Afr Vet. Med. Ass.*, 1960, **31**, 231.

SPECIFIC LOCUS MUTATIONS IN MAIZE BY CHEMICAL MUTAGENS

DIETHYL SULFATE (DES), an alkylating agent, and hydrazine, a thymidine specific chemical,[1,2] were used for inducing specific locus mutations. Seed of a multiple stock homozygous for the markers ql_6 lq_2 a_1 *et* A_2 *Dt* *C* and *R* were pre-soaked for 24 hours prior to treatment with 10 different concentrations of DES ranging from 0·003 M to 0·01 M for eight hours. The ge mination rate decreased from 89% to 6% w increasing concentration. The control seed ge minated within two days and the germinat was 96%. Some of the treated seed did n germinate until the ninth day after treatm Yellow-green, yellow, and albino chloroph sectors were observed on the leaves of plants, however, the yellow and albine sect were very few. The frequency of yellow-gr sectors is summarised in Table I.

TABLE I

Frequency of yellow-green sectors

Concentration of D.E.S.	Leaf number								Frequ of plant
	1	2	3	4	5	6	7	8	
0·003 M	9	7	10	6	6	3	2	..	19/
0·0035 M	6	4	7	3	2	..	1	1	10/2
0·004 M	7	8	7	..	2	..	..	..	8/1
0·005 M	..	..	2	1	2	1	..	..	4/14
0·006 M	1	1	2	1	..	..	..	..	2/4
0·008 M	1	3	3	1	..	..	..	..	4/7

The sectors were persistent after appear and continued throughout the development. correlation was observed between the mut concentration and sector number or sector or the position of the sectored leaf. None the plants had both albino and yellow sect Yellow and albino sectors occurred from third leaf onwards except in the case of 0·00 treatment in which one of the plants had yellow sector on the second leaf. The yell green sectors which were the most com could be observed on any leaf. In the 0·00 and 0·0035 M treatments, nine bifurcated 14 trifurcated leaves were observed. Po sterility which showed an increase with creasing mutagen concentration was a 13·18% in the 0·003 M treatment, and a 23·71% in the 0·005 M treatment.

Out of the 269 plants, two plants in the 0·00 treatment, two in the 0·0035 M treatment one in the 0·004 M treatment were ligul It may be pointed out, however, that the pe trance of the lq_2 is incomplete.

Five hundred seeds of the purple ho zygous dominant stock Bm_2 Lq_1 A_1 Su_1 *Pr* Gl_1 J_1 *Wx* and G_1 were treated with 0·00 hydrazine hydrate (80%) for 23 hours one hour of pre-soaking. By the fifth after treatment, only 295 seeds (58%) ger nated whereas in the control the germina was 96% within three days. There was no f ther germination in either case. Two go and two yellow seedlings were observed am the seedlings of the treated M_1 seed. In

M_1 selfed progeny a colourless (white) sugary kernel, two yellow kernels and four colourless (white) kernels were observed. No chlorophyll sectors were observed.

In maize it is known that nine genes including *A C R* and *Pr* are known to control the production of purple colour. The yellow colour can be explained on the basis that the Y gene gets expressed when at least one of the nine genes is present in the homozygous recessive condition. In order to get a colourless (white) kernel, the gene for yellow endosperm also must have mutated to the homozygous recessive (*yy*) state. The colourless (white) sugary phenotype can be explained on the basis that at least one of the genes for purple colour, the gene *Y* and the gene Su_1 are present in the homozygous recessive state. The golden seedling phenotype is observed when the gene g_1 is present in homozygous recessive stage. The two golden seedlings observed could be due to reversions of the G_1.

The observations suggest that hydrazine induced these simultaneous mutations of both the alleles to the 'homozygous recessive state' and the mutant phenotype is observed in the M_1 itself.[3] On the other hand, only chlorophyll sectors were observed in plants from DES-treated seed in the M_1 and gene mutations could be observed only in M_2. The higher frequency of yellow-green chlorophyll sectors compared to others, *i.e.*, yellow and albino, may reflect on the fewer number of loci involved. Alkylating agents in general may bring about a change in DNA directly by alkylating the bases or indirectly by breaking the sugar phosphate bond.[2] It is known that hydrazine specifically attacks thymidine in DNA and also induces simultaneous mutations in M_1.[1,3] However, alkylating agents may not produce simultaneous mutations like hydrazine. The present observations clearly suggest that hydrazine induces specific locus mutations in the M_1 itself even in maize.

V. S. G. Chandra Sekhar.
G. M. Reddy.

Dept. of Genetics,
Osmania University,
Hyderabad-7, *December* 9, 1970.

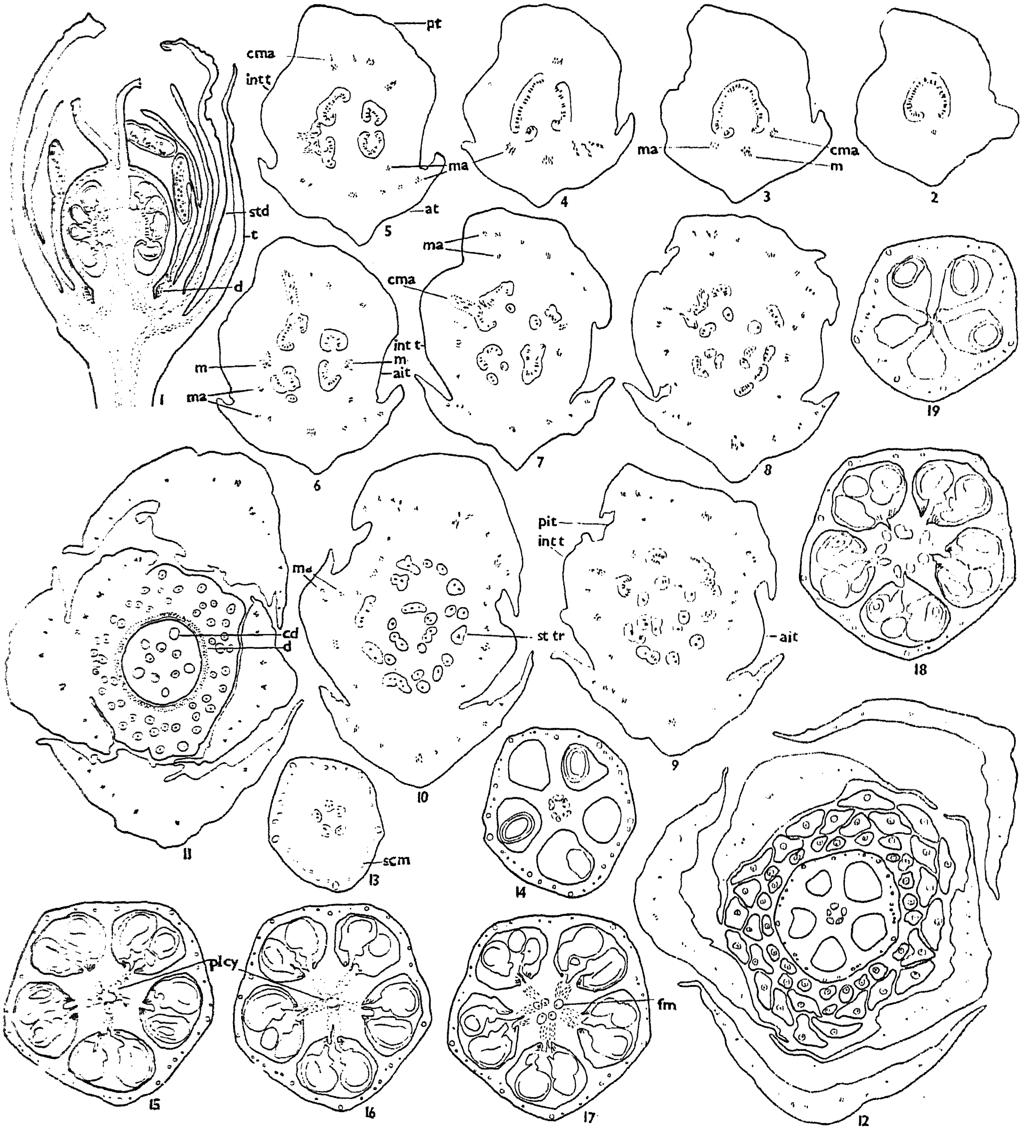
---

1. Freese, E., Freese, E. B. and Bautz, E., *Proc. Natl. Acad. Sci., U.S.*, 1961 *b*, **47**, 845.
2. —, "Molecular mechanism of mutations," In *Molecular Genetics*, Ed. Taylor, J. H., 1963, Part II, p. 207.
3. Jain, H. K., Raut, R. N. and Khamankar, Y. G., *Heredity*, 1968, Part 2, **23**, 247.

FLORAL ANATOMY OF *ORYGIA DECUMBENS* FORSK.

The floral anatomy of the Molluginaceae has received very little attention. The only paper in this regard is that of Sharma (1963) who has dealt with the floral anatomy of *Gisekia pharnaceoides, Semonvillea pterocarpa, Mollugo cerviana, M. nudicaulis, M. pentaphylla, Glinus lotoides* and *G. oppositifolius*. A similar study of *Orygia decumbens* of the Molluginaceae differs from the previous report of the family in many respects.

The pedicel has a stele of numerous conjoint, collateral bundles in a ring. It gives traces to the floral organs. In the quincuntial perianth the median trace for the anterior and posterior tepals arises independently earlier than the marginals and forms the tepal dorsal (Figs. 2, 4). One of the marginals of each of these tepals functions as a conjoint marginal and branches to form the marginals of both the outer and the inner tepals (Figs. 3, 5). This condition differs from that of *Semonvillea pterocarpa* and *Glinus lotoides* where the conjoint bundle is between the outer and the intermediate tepal (Sharma, 1963). Both the intermediate tepal and the anterior inner tepal opposite to it receive independently a midrib and a marginal each (Figs. 5-7). This is followed by the origin of a conjoint marginal (Fig. 7) which branches and forms marginals for both the posterior inner tepal and the intermediate tepal that is adjacent to it (Figs. 8-10) and a midrib for the posterior inner tepal (Figs. 8, 9). In this way the posterior inner tepal receives marginals from two conjoint bundles while the anterior inner one from one conjoint bundle. Such a condition is not reported previously in the Molluginaceae. All the marginals and midrib traces of the tepals branch frequently unlike in other members previously investigated. Meanwhile, in the receptacle two rings of vascular bundles are organised. The outer ring is of the staminal trunk traces and the inner ring is of the receptacular bundles (Fig. 10). The oppositepalous or alternitepalous disposition of the staminal trunk traces is not distinct. The staminal trunk traces branch many times. The outer two rings of these traces supply the flattened petaloid staminodes while the rest enter the stamens (Figs. 11, 12). The petaloid staminodes and the fertile stamens are connate at the base to form a small tube the inner side of which is secretory containing densely stained cells (Figs. 1, 11) resembling only *Semonvillea* *microcarpa* in this respect. This short staminal tube surrounds the base of the ovary where the receptacular stele organises five dorsals (Fig. 11). As the locules appear higher up in the ovary, the receptacular bundles which alternate with the dorsals, split and their xylem groups occupy the lateral position denoting the organization of the marginals of the carpels (Figs. 13, 14). At a higher level the marginals of each carpel fuse and subsequently merge with one another to form a placental vascular cylinder from where the ovular traces originate and supply the two rows of ovules in each locule (Figs. 15, 16). In the same upward sequence the placental vascular cylinder resolves into five fused marginals in the first



FIGS. 1–19. Fig. 1. L.s. flower bud, ×19, Figs. 2–12. T.s. flower bud from the base to the top in series at different levels, ×19, Figs. 13–19. T.s. ovary from the base to the tip in series at different levels, × 23. (*ait*, anterior inner tepal; *at*, anterior outer tepal; *cd*, carpel dorsal; *cma*, conjoint marginal; *d*, disc; *fm*, fused marginal; *int t*, intermediate tepal; *m*, midrib; *ma*, marginal; *plcy*, placental vascular cylinder; *pit*, posterior inner tepal; *pt*, posterior tepal; *scm*, secondary marginal; *std*, staminode; *st tr*, staminal trunk trace; *t*, tepal.)

instance (Fig. 17) and the constituent marginals of the adjacent carpels subsequently (Fig. 18) and are used up in supplying the ovules. Simultaneously the dorsals move to the periphery of the ovary and branch forming many secondary marginals (Fig. 13) supplying the carpellary wall unlike the two secondary marginals which are either conjoint with each dorsal as seen in *Gisekia* and *Glinus* or originating from the receptacular stele independent of each dorsal as in *Mollugo nudicaulis* (Sharma, 1963). These secondary marginals fuse higher up and fade away. However, the mid-dorsal bundles of the five carpels alone extend into the five filiform styles (Fig. 1) as in *Gisekia* and *Glinus* (Sharma, 1963). The placentation is axile. In the upper region of the ovary the septae separate from one another (Fig. 19) as in *Mollugo* and *Glinus* (Sharma, 1963) supporting the derived nature of the parietal placentation from the axile (Puri, 1952; Sharma, 1954).

To sum up, the flower of *Orygia decumbens* is monochlamydeous with five free quincuntial tepals. The vascular traces are three per tepal arising independently from the receptacular stele forming separate gaps. Both tepals and stamens exhibit different degrees of cohesion as indicated by their vascular traces and surface fusion. There is no adnation between the stamens and tepals. The adaxial base of the staminal tube is secretory. The gynoecium is pentacarpellary, syncarpous, superior and pentalocular. The axile placentation with two rows of ovules in each locule presents the appearance of parietal placentation at the apex. The numerous secondary marginals of the carpels are conjoint with their dorsals.

We are grateful to Professor B. Tiagi for encouragement.

Dept. of Botany, H. S. Narayana.
University of Rajasthan, B. C. Lodha.
Jaipur, India, *November* 23, 1970.

---

1. Puri, V., "Placentation in angiosperms," *Bot. Rev*, 1952, **18**, 603.
2. Sharma, H. P., *J. Indian bot. Soc.*, 1954, **33**, 98.
3. —, *Ibid.*, 1963, **42**, 19.

EFFECT OF ASAFOETIDA ON ROOT INITIATION IN BEAN PLANTS

The present note deals with the effect of commercial asafoetida on root initiation in bean plants.

In the experiments conducted, solutions (A) asafoetida (AF); (B) indole-butyric acid (IBA); and (C) indole-butyric acid and asafoetida combined solution of the following concentrations (ppm): (1) 0·195/2, (2) 0·390/2, (3) 0·781/2, (4) 1·562/2, (5) 3·125/2, (6) 6·25/2, and (7) 12·5/2 were prepared in half strength Hoagland's solution.

The bean seedlings were grown in dark, and when they reached 10″ to 12″ in height, they were removed and cut 5″ below the cotyledons, and only the aerial parts were used in the experiments.

The culture solutions were taken in different conical flasks and the cut seedlings were grown in them. The control plant was maintained in half strength Hoagland's solution. All plants were kept under constant illumination from 7.30 a.m. to 5.30 p.m., and maintained at room temperature. Every alternate day, solutions were changed. On the eighth day seedlings were removed to count the number of roots formed. Experiments with solutions A were repeated thrice and those with solutions B and C twice. The results are shown in Graph 1.

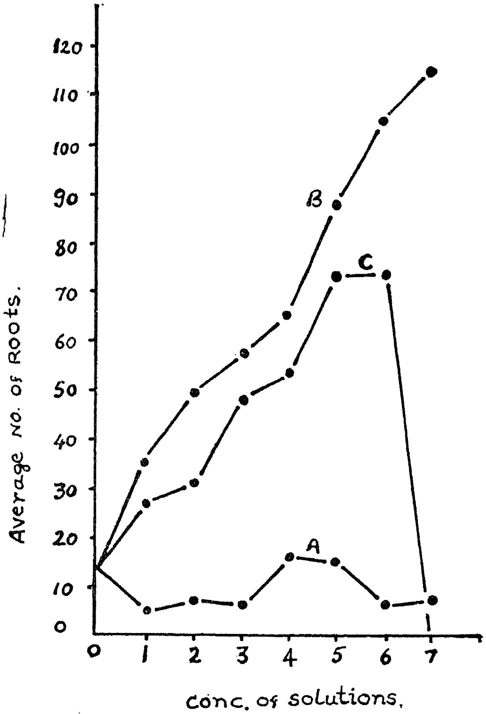


FIG. 1. Relation of soln. concentrations to the number of roots in Bean Seedlings. A=AF soln.; B=IBA soln; C=IBA & AF combined soln.

As can be made out from the graph, asafoetida alone has a slight enhancing effect on root initiation, particularly in concentrations

1·562/2 p.p.m. and 3·125/2 p.p.m. ; but in other concentrations it has a retarding effect. This latter effect is more striking in the combined solution, particularly in concentration 12·52/2 ppm root development is completely inhibited. In the remaining concentrations the number of roots produced is reduced approximately by 1/3 of the roots produced in IBA alone.

My thanks are due to Prof. L. Narayana Rao, Prof. T. Tatachar and Dr. H. Narasimhaiah for their kind help and encouragement. I am also grateful to the UGC for financial assistance.

Dept. of Botany, G. R. KANTHARAJ.
National College, Bangalore-4,
November 18, 1970.

---

1. *British Pharmacopia*, 1932.
2. *Plant Growth Substances*, 1965.
3. Kala, H. R. *et al.*, *Curr. Sci.*, 1963, 3, 136.
4. Hamberg, T., *Ark. Bot.*, 1946, B, 33 (2), **33**.

SOMATIC CHROMOSOME NUMBER OF *RHIZOPUS ARRHIZUS* FISHER

GENUS *Rhizopus* belongs to the order *Mucorales*. Nuclear behaviour of some members of this order had been studied in the past by Cutter (1942). Baird (1924) reported on the structure and behaviour of nucleus in *Rhizopus nigricans* Ehrb. An extensive investigation on this aspect specially of the nuclei of growing hyphae and of spores of many fungal representatives of the order *Mucorales* was made by Robinow (1957) in the recent past. Very recently, however, Falnagan (1969) has made study on the nuclear division in the vegetative hyphae of *Rhizopus nigricans* Ehrb and reported the somatic (n) chromosome number to be 16. No report has as yet been made regarding the chromosome number of *Rhizopus arrhizus* Fisher which prompted the authors to undertake the present work.

Young mycelia were made to grow in pure culture. The fresh and growing mycelia were harvested and then fixed in a fixative of absolute alcohol, acetic acid and chloroform in a ratio of 6 : 2 : 1. After fixation of 24 hours small quantity of material was put in a freshly prepared fixative and was stained with acetocarmine. A few threads of mycelia were investigated for their nuclear division by squash method.

The nuclei in the vegetative hyphae of the fungus were found to divide according to conventional mitosis, 16 chromosomes were observed during metaphase stage of mitosis which is the first report of the somatic chromosome number (n) of this species *Rhizopus arrhizus* Fisher.

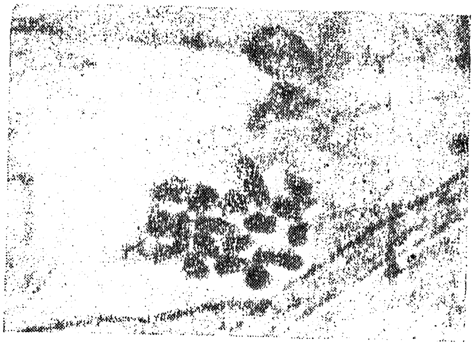


FIG. 1. Photomicrograph showing nuclear division (Metaphase stage) of a vegetative hypha with 16 chromosomes, × 3,600.

The authors express their gratitude to Professor J. P. Sinha, for the facilities extended to them and to Shri K. D. N. Akhaury for his help in preparing the photomicrographs.

Department of Botany, KALYAN GANGULY.
Ranchi College, MAHENDRA PRASAD.
University of Ranchi,
November 27, 1970.

---

1. Baird, E. A., *Trans. Wiscon. Acad. Sci.*, 1924, **21**, 357.
2. Cutter, V. M., Jr., *Bull. Torrey Bot. Club*, 1942, **69**, 692.
3. Robinnow, C. F., *Canad. Jr. of Microbiol.*, 1957, **3**, 789.
4. Falnagan, Patrick, W., *Canad. Jour. of Bot.*, 1969, **47** (12), 2055.

EFFECT OF MORPHACTIN ON LEAF MORPHOLOGY AND TENDRIL FORMATION IN *MOMORDICA CHARANTIA* LINN.

RECENTLY, certain morphogenetically active derivatives of fluorine-9-carboxylic acid (morphactins) have evoked considerable interest, both for possible use in agriculture and as an aid in solving problems of morphogenesis in higher plants.[1] The strong and multifarious action of morphactins on growth and development sort out these chemicals as novel growth regulators.[2] In our studies on physiology of Indian cucurbits interesting observations were made on the effect of morphactin on tendril growth and leaf morphology of *Momordica* plants ; the results are summarized in this report.

As reported elsewhere,[3] plants of *Momordica* were grown in earthenware pots in the garden, and sprayed with the desired concentration (2 mg, 5 mg/pot) of morphactin when the seedlings were 12–15 days old. *Momordica charantia* Linn. is a slender much-branched, twining annual herb which climbs with slender, elongate, pubescent simple tendrils (Fig. 1 *a*). The leaves are orbicular in outline, cordate at the base and deeply divided into 5-7 lobes; the lobes being acute, apiculate, and coarsely spinous dentate (Fig. 1 *b*). Morphactin treatment affected the dormancy of the lateral buds, and as a result the usual vine habit of growth was completely changed, and the treated plants were bushy in appearance with short branches. The bushy habit of the treated plants was expressed not only in the shorter shoots and nodes, but also in partial suppression of tendril formation (Fig. 1 *a*). Even after one spray treatment (2 mg/pot) not a single tendril could be seen for about a month after which the tendrils formed normally. However, by increasing the spray levels (5 mg/pot and above) tendril formation could be arrested indefinitely. Further, it was interesting to note that under the influence of morphactin some of the branches of the treated plants started producing almost entire leaves instead of deeply pinnatifid-lobed leaves (Fig. 1 *b*). Several genes are known which modify the form of leaves.[4] It remains to be explored whether morphactin treatment affects the activity of such genes. However, it was almost a coincidence that usually till the entire leaves developed no tendrils were formed. Thus it would appear that morphactin treatment affected both leaf morphology as well as the tendril formation simultaneously.

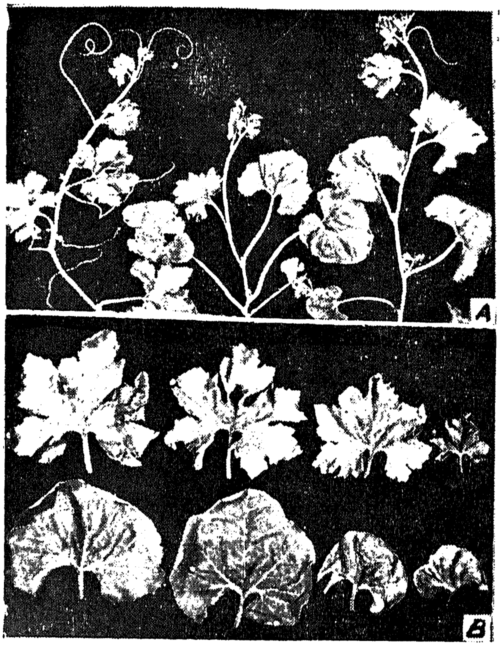


FIG. 1. (*a*) (From L. to R.). A branch from control plant showing tendrils; a branch from plants once sprayed with morphactin (2mg/pot) without any tendril; a branch from morphactin treated plants 1½ months showing recovery from morphactin treatment. (*b*) Above: Leaves from control plant. Below: Leaves from treated plants.

Interpretation of the morphological nature of the tendril has been controversial. In Cucurbitaceae it has been variously interpreted as axis *plus* leaf, leaf branch, stipule, 'out growth of the bud axis', 'stipule-stem complex', etc.[5] The specific inhibition of tendril formation and not the lateral branches following treatment with morphactin would possibly suggest that tendril has a specific character distinct from the usual axillary shoot of plants. However, it is known that though the meristem of the tendril originates by cell division from the totipotent cells of the shoot apex, determination as a tendril is established early in the ontogeny of the primordium, and perhaps it is because of this that, while the cells of the tendril differentiate into essentially the same cell types as those in the vegetative shoot, 'the pattern and the product are different'.[6] Therefore, the production of tendrils might appear to be an interesting case of gene activation. If it be so, it would be interesting to know how it is regulated at the shoot apex, and precisely what role morphactin plays in bringing about inhibition of tendril growth.

Botany Dept., NARENDRA SANKHLA.
Universiy of Jodhpur,
Jodhpur, *October* 5, 1970.

---

1. Schneider, G., Mohr, G. and Erdmann, D., *Merck Blatter*, 1967, **17**, 21.
2. —, Erdmann, D., Lust, S. and Niethammer, K., *Nature*, 1965, **208**, 1013.
3. Sankhla, N. (In press).
4. Mc Kelvie, A. D., *Radiation Bot.*, 1962, **1**, 233.
5. Whitaker, T. W. and Davis, G. N., *Cucurbits*. 1962, Leonard Hill (Books) Ltd., London.
6. Millington, W. F., *Amer. Jour. Bot.*, 1966, **53**, 74.

ISOLATION OF A NEW CULTIVAR OF EUROPEAN DILL (*ANETHUM GRAVEOLENS* LINN.) IN INDIA

DILL is an important condiment crop in India, the leaves and fruits of which are extensively used in culinary and medicine besides export of over 600 tons of its fruits annually. The systematics of the Indian Dill plant has long been a controversy and the author[1,2] has recently described it under *Anethum graveolens* sub sp. *sowa* (Roxb. ex Flem.) Gupta. Pharmaceutically, the Indian type Dill fruits are regarded as inferior to its European counterpart because of low percentage of *carvone* and large quantity of *dillapiole* present in its etherial oil.[7] The exotic Dill, therefore, has been introduced under cultivation in farms of Jammu and Kashmir[5] and later at CIMPO Farm, Haldwani, in Tarai region of Uttar Pradesh[3]; the oil distilled from these crops were found to conform with pharmacopoeial standard. A lower (fruit) yield and higher rate of seed shattering during ripening has been the main drawbacks of the crop in comparison to the Sowa crop for large-scale cultivation in India though the collection of full-grown green fruits has been recommended to reducing such losses.[6] A high-yielding cultivar, therefore, has long been desired.

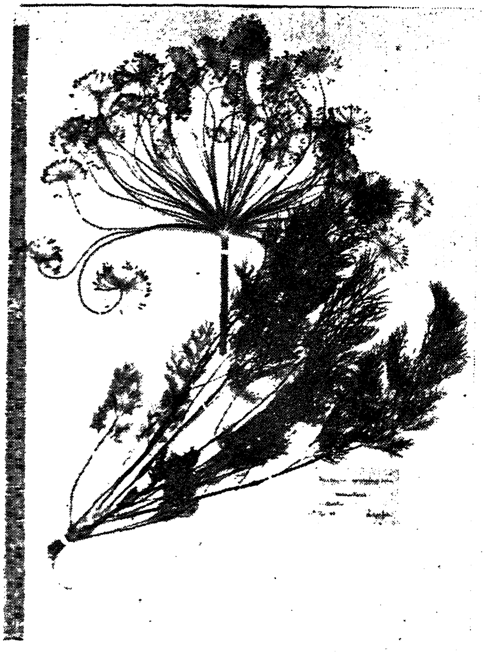


PLATE. I. European Dill : (Haldwani selection).

The author obtained 20 commercial cultivars of the exotic and indigenous type Dill from 15 major Dill-growing countries of the world and performance trial, as a winter annual, was laid at CIMPO Farm, Haldwani (Nainital). The experimental plots were laid out at a distance of 30 m from each other, in a homogeneous, loam soil, rich in humus and nutrients. The range of variations in growth, branching and seeding including size and weight of the umbels, umbellules and fruits were recorded and has been reported partly elsewhere.[4] A number of single plant selections were made and a promising cultivar was thus isolated which on further randomized replicated trials gave significantly (statistically) higher yields than the parent stock. This selection is dwarf in size (average height 96 cm), bearing fewer comp. umbels (average 23·50 cm), each of which is larger in size (peduncle 22 cm in length) and bigger (dia. 29·00 cm) in spread (*see* Plate I); these in turn bear over 1,600 mature fruits in a terminal umbel and over 1,000 fruits in the axillary ones. The mature, full-grown fruits are conspicuously bigger in size and heavier in weight such that a single plant yield comes to 38·25 gm (average fresh weight) fruits in comparison to 27·23 gm from the much-grown English stock. The dimension of peduncle, pedunculii and pedicel too are conspicuous and the stouter nature of the pedicel, in the opinion of the author, contribute to the development of about 90% of the flowers into mature fruits. This selection is called as 'Dill : Haldwani Selection' and is under further approbation trial.

Central Indian Medicinal Plants Organization,
Bangalore, *November* 16, 1970.
RAJENDRA GUPTA.[1]

---

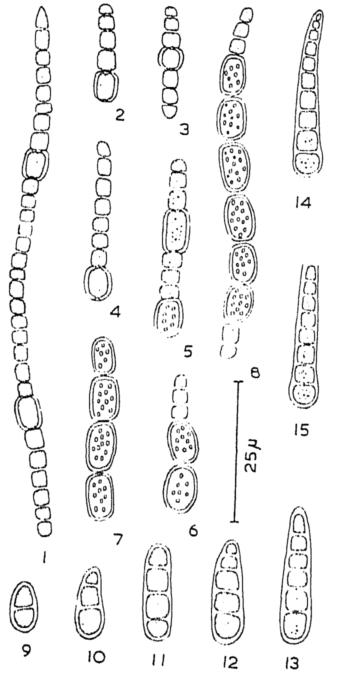
1. Gupta, Rajendra, *Indian Oil & Soap J.*, 1969, **35** **6**, 129.
2. —, *Dissertation* Agra. Univ., 1970 ; *Abst. CSIR News*, 1970 20, **18**, 143.
3. — and Baslas, K. K., *Indian Perf.*, 1967, 9, **2**, 22
4. —, Duhan, S. P. S. and Mehrotra, A. P., *Proc. Indian Sci. Cong.*, 1969, **56** (*Bot.*) *Abst.* 136 329.
5. Handa, K. L., Kapoor, L. D. and Channa, O. N., *Indian J. Agric. Sci.* 1953, 28 Part II, **6**, 147.
6. Kapoor, L. D. and Abrol, B. K., *J. Sci. Industr. Res.*, 1961, **20 C**, **2**, 54.
7. Malviya, B. K. and Butt S., *Proc. Ind. Acad. Sci.*, 1940, **12 A**, 25.
8. *Annual Report* : *CSIR* 1969. *CIMPO*, Selection of cultivars of Dill, 81 (Council of Scientific and Industrial Research, New Delhi) ; *Abstr. CSIR News*, 1970, 20, **16**, 123.

ON THE STRUCTURE AND MODE OF GERMINATION OF AKINETE OF *ANABAENA VARIABILIS* KUTZ VAR. *KASHIENSIS* (BHARADWAJA) FRITSCH

DURING study of the sewage algae of Lucknow, we came across *Anabaena variabilis* var-*kashiensis* in the month of September 1969. It was thought desirable to study the structure and life-history of this species of *Anabaena*. The description is based on material preserved in 4% formalin. The alga was found growing in sewage along with *Navicula*, *Phormidium*, *Oscillatoria* and *Myxosarcina*.

The thallus is soft and mucilaginous and forms deep green patches on the side of the nala along with other algae. The trichomes are irregularly curved and more or less entangled with each other. A trichomes are devoid of mucilaginous sheath.

The cells are barrel-shaped, 4·2 μ broad and 2·8 μ to 4·2 μ long. The contents of the vegetative cells are coarsely granular. The cells are slightly constricted at the joints. The end cell is pointed (Fig. 1).



FIGS. 1–15. Fig. 1. End Cell pointed. Figs 2–4. Varying shapes of heterocyst. Fig 5. Cylindrical heterocyst in relation to akinete. Fig. 6–8. Chains of akinetes. **Figs. 9–14.** Germination stages of Akinete (two to ten-celled germling). **Fig. 15.** Point at which exospore dissolved.

The heterocysts are usually single, intercalary wider than the vegetative cells and occur at regular intervals throughout the length of the trichome. In the young filaments the heterocysts exhibit difference in size and shape. Obviously, one is older than the other (Figs. 2, 3, 4). They are 5·6 μ broad and 5·6 μ to 7·0 μ long, cylindrical or barrel-shaped,

The akinetes are formed in long or short chain of two to six (Figs. 6, 7, 8) and are remote from the heterocysts (Fig. 5). They are usually barrel-shaped with flattened ends, 8·4 μ to 9·8 μ long, 5·6 μ to 7·0 μ broad with thick firm exospore and delicate endospore.

Various stages of akinete germination has been observed in nature. When young, the akinetes are barrel-shaped but later become ovate or oblong and the colour changes from blue-green to pale-green and finally to brownish. In the germination of akinetes at first a two-celled germling is formed (Fig. 9) which undergoes further division and forms a three- to few-celled germling (Figs. 10, 11, 12, 13, 14). During germination the exospore from one side dissolves (Fig. 15) and the germling comes out from the exospore. As a result of further division, the germling grows into a new filament. The germination of akinete in *A. variabilis* Kutz var. *ellipsospora* differs from the present form. In the former, during the germination, the part of exospore becomes dissolved and the contents escape along with the endospore. At this stage, division takes place and develop into a new filament.

Our grateful thanks are due to Dr. P. N. Saxena for valuable suggestions, P. C. Roy for technical help and the Director, National Botanic Gardens, Lucknow, for providing facilities.

Dept. of Botany, V. P. SINGH.
University of Delhi,
Delhi-7; and
Algology Laboratory, INDIRA ARORA.
National Botanic Gardens,
Lucknow, *December* 7, 1970.

---

1. Fritsch, F. E., *J. Indian bot. Soc.*, 1949, **28** (3), 136,
2. Venkataraman, G. S., *Proc. Nat. Inst. Sci. India*, 1958, **24** (5) 229.
3. *A kashiensis* Bharadwaja, *Proc. Indian Acad. Sci.*, 1935 **2 B**, 105, Fig. 6 C–G.
4. Gonzalves E. A. and Kamat, N. D., *Hydrobiologia*, 1959, **13**, 236

TOLERANCE OF BLUE-GREEN ALGAE TO PESTICIDES

THE use of high-yielding, fertilizer responsive dwarf rice varieties together with the use of powerful pesticides, some of which are applied to irrigation water makes it relevant to consider whether algal cultures could still be used under these conditions. The positive influence of algalization on the high-yielding rice varieties under high levels of fertilization has been earlier shown.[6-8] The present communication is a preliminary report on the tolerance of nitrogen-fixing blue-green algae to some pesticides.

Twenty-eight strains of blue-green algae belonging to five different genera were tested against varying concentrations of eight pesticides (Table I). The cultures were maintained under identical conditions of illumination (*ca* 5,000 lux) and temperature (30 ± 1° C). The difference in growth of treated and untreated cultures was used to assess the effect of pesticides under test. The growth of the algae was measured at the end of 15 days in terms of the optical density (680 mμ) of the methanol extract.

TABLE I

Tolerance of nitrogen-fixing and non-nitrogen-fixing blue-green algae to pesticides. Figures in parenthesis refer to the number of strains tested

Pesticides	Rates (kg/H)*	*Anabaena*		*Nostoc*		*Aulosira fertilissima*		*Tolypothrix tenuis*		*Anacystis nidulans*	
		TS	TL	TS	TL	TS	TL	TS	TL	TS	TL
Cerason	.. 0·03- 0·34	8 (9)	> 20	11 (16)	> 20	1 (1)	20	1 (1)	200	1 (1)	200
Diathene	.. 1·7 – 16·8	8 (9)	100	9 (16)	100	1 (1)	100	1 (1)	[illegible]00	1 (1)	100
2, 4-D	.. 1·4 – 4·5	8 (9)	200	10 (16)	> 100	1 (1)	200	1 (1)	2[illegible]0	1 (1)	200
Delapon	.. 5·6 – 56	8 (9	200	15 (16)	200	1 (1)	200	1 (1)	200	1 (1)	200
Propazine	.. 2·24	8 (9)	>200	15 (16)	> 200	0 (1)	< 2	1 (1)	1,000	1 (1)	4,000
Cotoron	.. 1·12 2·24	9 (9)	>200	14 (16)	>1,000	0 (1)	< 2	1 (1)	4,000	1 (1)	4,000
Diuron	.. 0·6 ·112·1	5 (9)	>200	9 (16)	>1,000	0 (1)	< 2	0 (1)	< 2	1 (1)	200
Linuron	.. 0·6 – 6·9	8 (9)	>200	12 (16)	> 200	0 (1)	< 2	1 (1)	2000	1 (1)	10

* Thomson.[5] TS = Tolerant strains; TL = Tolerance level (kg/H).

Table I shows the recommended rates of the pesticides[5] and the number of tolerant strains together with their tolerance levels. A large percentage of the strains tested has been found to show a high tolerance limit to all pesticides, which is many times more than the recommended doses of application. Of particular interest is *Tolypothrix tenuis*, a powerful nitrogen-fixer widely used in inoculation trials, which was found to grow in presence of high concentrations of all pesticides, except Diuron (Table I). The related *Aulosira fertilissima*, while tolerating high levels of Cerasan, Diathene, 2, 4-D and Delapon, was sensitive to the substituted urea compounds like Cotoron, Diuron and Linuron as well as to the triazine herbicide, Propazine (Table I). The non-nitrogen-fixing *Anicystis nidulans* was found to tolerate high concentrations of all the pesticides examined. Some strains of algae have been used to assay the soil-applied herbicides.[1-4] Besides being able to function in presence of high levels of nitrogenous fertilzers,[6,7] the present investigation indicates that these algae can be used in presence of pesticides as well.

Our grateful thanks are due to Dr. B. P. Pal and Dr. W. V. B. Sundara Rao for their interest in the study.

Division of Microbiol., G. S. VENKATARAMAN.
I.A.R.I., B. RAJYALAKSHMI.
New Delhi-12, *December* 7, 1970.

---

1. Atkins, C. A. and Tchan, T. T., *Plant and Soil*, 1967 **17**, 432.
2. Pillay, A. F. and Tchan, Y. T., *Soil Biology*, 1969, **10**, 23.
3. — and —, *Ibid.*, 1970, **12**, 20.
4. Tchan, Y. T. *Festskrift til Hans Laurits Jensen*, 1968, p. 131.
5. Thomson, W. T., *Agricultural Chemicals*, Thomson Pub Davis, Calif., 1967. **2** (4).
6. Venkataraman, G. S. and Goyal, S. K., *Sci. and Cult.*, 1969, **35**, 58.
7. —, and —, *Mikrobiologiya*, 1969, **38**, 709.
8. —, *Phykos*, 1966, **5**, 164.

REVIEWS AND NOTICES OF BOOKS

Magnetic Resonance. Edited by C. K. Coogan, Norman S. Ham, S. N. Stuart, J. R. Pilbrow and G. V. H. Wilson. (Plenum Press, New York and London), 1970. Pp. xii + 386. Price $ 16.00.

Scientists thrive on problems. As soon as they solve one, they turn to another. Perhaps this is why magnetic resonance has attracted so many researchers over the last 20 years : the problems are numerous, fascinating and important. They are also largely unsolved, but the effort to solve them has revealed a staggering variety of exciting applications and ramifications.

Of course, all this research activity creates another problem—how to keep up with progress in the field. The best solution to this problem may well be a book like the present volume, *i.e.*, a book that presents papers by leading research workers on the subjects and problems that interest them most. As might be expected, these papers do not deal primarily with routine applications ; instead, they present important recent work on the physical aspects of resonance phenomena and advanced theoretical discussion. As a result, they place the reader at the frontiers of research in such areas as high-resolution nuclear magnetic resonance, nuclear quadrupole resonance, wide-line NMR, and the electron spin-resonance of radicals and solids.

Because of the authoritative material of its subject, the book will be of great value to theoretical, atomic, plasma, space, electron, molecular, chemical, and solid state physicists ; organic, inorganic, and physical chemists ; and materials scientists. C. V. R.

Cryogenic Laboratory Equipment. By A. J. Croft. (Plenum Publishing Corporation, New York and London), 1970. Pp. x + 182. Price $ 11.50.

A practical introduction to the fast-growing field of cryogenics. The author deals with such equipment as : sources of cryogenic liquids, containers, methods for transfer ; liquefiers and their associated machinery, methods and equipment for gas storage, purifcation, etc., instruments for measurement of temperature, flow, level, leak detection, automatic control, etc. ; materials and practical methods for making low-temperature equipment ; special laboratory design features for low-temperature work ; and the hazards of low-temperature work and the precautions to be taken. C. V. R.

New Manuals on Ultraviolet and Infrared. Published by Beckman. (Systronics, Shahibag House, Shahibag, Ahmedabad-4. Sole Agents for Beckman products in India.)

A new, 92-page reference manual for college-level study of ultraviolet visible spectrophotometry has been published by Beckman Instruments.

An Introduction to Ultraviolet Spectrophotometry, written by Robert J. Manning, principal chemist, Applications Research, at Beckman, describes the basic theory and includes 12 experiments to increase familiarity with UV instrumentation and analytical techniques. The experiments were conducted on the company's ACTA series of spectrophotometers but are applicable to other ultraviolet instruments.

All experiments clearly state purpose, materials, and equipment needed, procedures are explained, and considerations discussed. The Manual also privides a glossary of ultraviolet spectrophotometric terms.

Modern Practices in Infrared Spectroscopy, is the title and subject of a new 168-page Manual by Kenneth E. Stine of Beckman Instruments, Inc. Designed for college-level study, the book is published by Beckman and sells for $ 5.00 in quantities of 1 to 4. Discounts are available for larger quantities.

The basic theory and experiments it describes were conducted on Beckman's IR-33 Spectrophotometer but are applicable to other infrared (IR) instrumentation. A 22-page introduction to fundamental aspects of IR spectroscopy is included, along with 13 basic experiments. Each experiment is clearly described, including a statement of purpose, apparatus and materials required, and specific procedures. Review questions and tables for entering results are provided.

The Manual also includes general references and a glossary of applied spectroscopy terms.

Ultrastructure of Bacterial Viruses. By Anna S. Tikhonenko. (Plenum Publishing Corporation, 114, Fifth Ave., New York, N.Y. 10011), 1970. Pp. x + 294. Price $ 19.50.

The relatively simple organization of viruses, carrying their own genetic system providing for autoreproduction and variation, has attracted the attention of investigators seeking to solve fundamental biological problems. Viruses of bacteria, or bacteriophages because of their comparative accessibility and the simplicity of working with them have come to the forefront in biological researches throwing light on basic problems like gene structure, genetic code, protein synthesis, etc.

The book under review is specially concerned with the macromolecular structure of phages and is based on the results of detailed investigations carried out by the author and her collaborators. The book presents electron-microscopic techniques of investigation of bacteriophages, morphological classification of phages, action of physical and chemical agents on phages, phosphatase activity of phages and organization of phage DNA in its replication. The book is generously illustrated with about 130 original electron micrographs more than half of whch are full-page plates. A. S. G.

Pest Control in Rice (PANS Manual No. 3). (Published in Britain by the Ministry of Overseas Development, PANS Manuals, 56/62, Gray's Inn Road, London W.C. 1), 1970. Pp. ii + 270. Price 12 *sh.* 6 *d.*

We wish to draw the attention of our readers to the excellent publications of the Tropical Pesticides Research Headquarters and Information Unit, 56/62, Grays Inn Road, London W.C. 1, England. PANS (Pest Articles and News Summaries) is a quarterly and contains articles, research reports, conference reports, notes and news, new books, etc. The annual subscription is £ 2·50. PANS Manuals are a series of hand-books, each one dealing with all aspects of pest control in a single tropical crop. The aim of the journal and the manuals is to inform workers directly concerned with the crop of the most recent techniques for pest control, especially under tropical conditions.

Much is happening in the field of rice-growing. New rice varieties with very high yield potential have been developed, but to realise the expected high yield, several factors have to be carefully looked into, such as agronomic practices, mechanised cultivation, irrigation, and above all prevention of crop losses from pest attacks.

This Manual No. 3 assembles all aspects of pest control in rice, potential losses from insects, diseases, weeds, rats, etc. There is no doubt that this is a timely publication, and will be useful to people directly concerned with growing rice.

We have also received a copy of the quarterly journal of PANS (Pest Articles and News Summaries), Vol. 16, No. 3, September 1970, which, amongst others, contains the following articles: Pesticide Research in Developing Countries, by J. H. Taylor; New Hope for Hormone Mimics as Pesticides, by P. E. Ellis *et al.*; Use of Plant Pathogens in Weed Control, by C. L. Wilson; Herbicides in Cotton, by S. de Almeida; Thread Blights in Cocoa, by D. Leston; and Chemical Relationships and Nomenclature of Pesticides, by C. T. Duval.

A revised edition of Manual 2 on pest control in groundnuts has also been issued.

A. S. G.

Books Received

Lac Bibliography Literature. (Shellac Export Promotion Council, 14/1 B, Ezra Street, Calcutta-1), 1970. Pp. vi + 216. Price not given.

Mineral Economics. By R. K. Sinha and N. L. Sharma. (Oxford and IBH Pub. Co., Oxford Building, N-88, Connaught Circus, New Delhi-1), 1970. Pp. ix + 317. Price Rs. 18.

Annual Review of Genetics (Vol. 4). (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California, 94306), 1970. Pp. ix + 523. Price U.S.A.: $ 10.00; Foreign: $ 10.50.

The Wealth of India—Raw Materials (Vol. VI). *Supplement—Livestock (Including Poultry).* (Publications and Information Directorate, CSIR, Hillside Road, New Delhi-12), 1970. Pp. xi + 274. Price Rs. 60·00.

Guide to the Bird Gallery. By S. T. Satyamurti. (The Director of Stationery and Printing, Madras), 1970. Pp. iv + 195 + xii. Price Rs. 11·30.

Annual Report of the National Institute of Nutrition. (National Institute of Nutrition, ICMR, Hyderabad-7), 1970. Pp. iv + 140.

2621-71. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, L.P.T., Superintendent, at The Bangalore Press, Bangalore-18.

A DIRECT EVIDENCE FOR THE MISDIVISION HYPOTHESIS

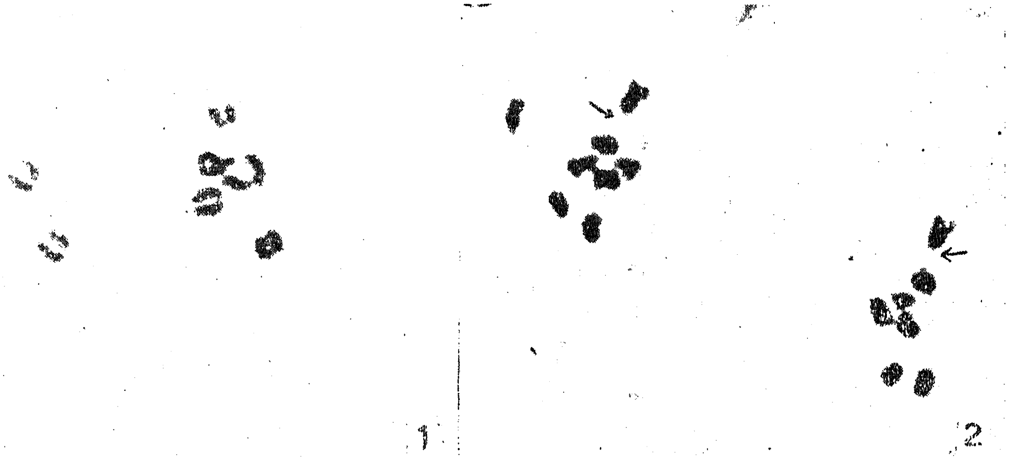
D. SRINIVASACHAR AND JAWAHAR LAL
Division of Genetics, Indian Agricultural Research Institute, New Delhi

ABSTRACT

In a plant of *Pennisetum typhoides* that had arisen from gamma irradiated seeds one of the chromosomes was broken transversely at the centromere giving rise to two telocentries, providing, a hitherto lacking, direct evidence for the misdivision hypothesis. Besides showing how the chromosome number may increase in evolution this has also shown that telocentrics can survive in nature.

INTRODUCTION

IN both animal and plant kingdom variations in chromosome number, within a species and between the sexes of the same species, have frequently been reported. Apart from the differences attributed to ploidy, hyper- or hypoploidy, these variations have been explained as due to structural hybridity caused by fusion and fragmentation.[1,4,5,10] Centric fusion, termed the Robertsonian system,[9] is perhaps the commonest cytological rearrangement to account for the evolution from a high to a low diploid number. Centric fusion is accompanied by the formation of a new bi-armed chromosome, a small centric fragment that is lost in subsequent cell divisions and a reduction in chromosome number by one. Opposed to centric fusion is centric fission common in plants[2] and in some *Lepidoptera*[13] wherein fragmentation of metacentric chromosome occurs to give rise to two telocentrics and so increasing the chromosome number by one. The term misdivision was applied by Darlington[2,3] to the phenomenon of transverse breakage of chromosomes at the centromeric region. Although misdivision was cited by Darlington[2] in *Fritillaria* and by Rhoades[8] in maize, so far, there has been no direct evidence for this hypothesis.



FIGS. 1-2. Fig. 1. P.M.C. in diakinesis with $1_{III} + 6_{II}$. Fig. 2. P.M.C. in anaphase I with 8 and 7 chromosomes at the opposite poles. Arrows indicate the telocentrics with terminal attachments.

RESULTS AND CONCLUSION

In a plant of pearl millet, *Pennisetum typhoides*, raised from seeds irradiated with 35 kilo rads of gamma-rays, a few cells undergoing meiosis were found to contain $2n = 15$ chromosomes instead of the normal 14. In one such cell, at diakinesis, there were six bivalents and a trivalent (Fig. 1). In another cell, in late anaphase I, eight and seven chromosomes were seen in the opposite poles (Fig. 2). In two of these chromosomes with terminal centromeres the spindle attachments could be clearly seen. They have apparently arisen as a result of transverse breakage in the centric region of one of the long chromosomes with a median centromere, as all the chromosomes of pearl millet have a median or near median centromere and the arm ratio ranges from a minimum of 0·27 in the nucleolus organizing chromosome to 0·85.[11] As dry seeds were irradiated and the effect of radiation is immediate this breakage must have occurred in the somatic cells. The telocentrics must have survived many somatic cell divisions to appear in the meiotic divisions of the pollen mother cells. The two telocentrics have paired to give rise to a trivalent seen in Fig. 1. The orientation of the trivalent was such that while each of the two telocentrics went to the opposite poles, their unbroken partner with a median centromere went to one of the poles increasing the chromosome number at that pole by one. Thus, a cell with eight and seven chromosomes at the opposite poles, as in Fig. 2, resulted. As the telocentrics appeared in the immediate generation after seed irradiation, it constitutes a direct evidence for the hypothesis of misdivision. The telocentrics are not only seen directly under the microscope with their terminal spindle attachments, their presence is further confirmed by the formation of a trivalent in meiosis and by the increase in the chromosome number by one.

Darlington[2] and White[12] thought that all telocentrics are unstable and hence do not survive in nature. White[12] doubted whether the chromosomes in which the centromeres appear to be terminal are really telomeric and used the term acrocentric. He argued that if the terminal structures sometimes found in acrocentrics are in fact short arms, it follows that these chromosomes will have centromeres identical to those of metacentric chromosomes and, therefore, it is the structural normality of their centromeres that account for the stability of such chromosomes. The presence of a minute second arm is immaterial for the stability of a chromosome is borne out by the present case as the chromosomes have terminal spindle attachment and there is no sign of any secondary change like translocation in these chromosomes. There is no evidence that a telocentric is unstable because its centromere is terminal. Although telocentric chromosomes rarely occur in plants, a few cases have been reported.[6]

Two types of gametes are expected to occur with telocentrics: One type would be deficient in a chromosome arm and would be at a disadvantage in competition with normal gametes unless the arm lost is genetically inert or the loss nullified by polyploidy. The other type would have telocentrics in excess of the normal. If these gametes compete successfully with the normal ones they give rise to polysomic individuals. Such polysomic individuals which are selectively disadvantageous in sexually reproducing organisms would be eliminated.

1. Cave, M. S. and Bradley, M. V., *Amer. J. Bot.* 1943, **30**, **142**.
2. Darlington, C. D., *Jour. Genet.*, 1939, **37**, **341**.
3. —, *Ibid.*, 1940, **39**, **351**.
4. Hughes, R. D., *Genetics*, 1939, **24** **811**.
5. Levan, A. and Emsweller, S. L., *Jour. Here* 1938, **29**, 291.
6. Love, R. M., *Canad. J. Res.*, 1943, **21**, 257
7. Marks, G. E., *Amer. Naturalist*, 1957, **91**, 223.
8. Rhoades, M. M., *Genetics*, 1940, **25**, 483.
9. Robertson, W. R. B., *J. Morphology*, 1946, **2** 179.
10. Stalker, H. D., *Proc. Nat. Acad. Sci.*, U.S.A., **194** **26**, 575.
11. Venkateswaralu, J. and Pantulu, J. V., *J. Heredit* 1968, **59**, 69.
12. White, M. J. D., *Animal Cytology and Evoluti* Cambridge Univ. Press, 1954.
13. —, *Biol. Prog.*, 1957, **3**, 109.

ERADICATION AND UTILIZATION OF WATER HYACINTH—A REVIEW—AN ADDITION

K. M. JAGADEESH AND C. S. LAKSHMINARAYANA

37, Journalists' Colony, Bangalore-2

THE above review, recently published by Archana Sharma,[1] needs important additions regarding the eradication and utilization of water hyacinth. In this review, the author has not mentioned the most successful method of eradication by 2, 4-dichlorophenoxyacetic acid (2, 4-D) and also the recent work on the utilization of water hyacinth for nutrient removal from polluted waters.

ERADICATION

To eradicate *Eichhornia crassipes*, L.[3,4] Hild brand (1946) used 2, 4-D for her experimen Various tests performed on infestations in stream with an appreciable current and in a pond with relatively quiet water showed that 2, 4-D could completely kill water hyacinths. In experiments performed in artificial pits, canals, bayous and other waterways in Louisiana during 1948-49, Hitchcock *et al.* (1949, 1950) showed that at any time throughout the year, mats of hyacinths could be killed and sunk within 2 to 3 months by a dosage of 9 kg 2, 4-D/ha (8 lb/acre).

The related compound 2, 4, 5-T was found to be less effective, as were all the non-hormone herbicides, none of which significantly improved the control when added to 2, 4-D. So 2, 4-D has become generally accepted as the best herbicide for *Eichhornia crassipes*, L. and is used in control programmes throughout infested areas in Africa, notably the Congo and the Upper Nile, and in the Southern U.S.A.

UTILIZATION

The municipal sewage, agricultural and industrial effluents contain levels of nitrogen and phosphorus that are much higher than concentrations in natural waters. *Eichhornia crassipes*, L. absorbs large amounts of nutrients from polluted waters and its removal might constitute an effective means of stripping nutrients from effluents or natural waters. The utilization of water hyacinth for this purpose has been demonstrated recently by Claude E. Boyd[2] (1970).

A series of small ponds in which the waste water travels from one pond to the next are constructed for the removal of the nutrients. In these ponds water hyacinths are grown (Fig. 1). These plants could be harvested at a continual rate and the population maintained in a rapidly expanding phase throughout the growing season. Mineral uptake rates per unit of dry matter increase are greater in plants in a rapid growth phase. Waters beneath dense hyacinth stands are anaerobic and additional nitrogen would be lost through denitrification. There would be considerable microbial activity beneath the hyacinths, and nutrients would be absorbed by these organisms.

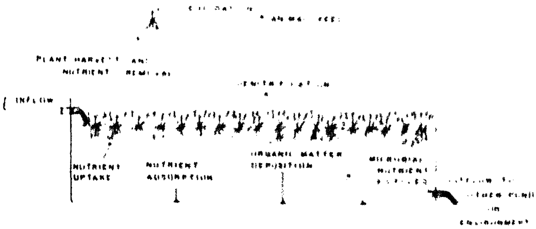


FIG. 1. Diagram of the processes involved in mineral nutrient removal from effluents by water hyacinths (*Eichhornia crassipes*). (Reproduced from Claude E. Boyd, *Eco. Bot.*, Vol. 24 No. 1, 1970.)

Claude E. Boyd has calculated the mean mineral nutrient composition of dried samples of *Eichhornia crassipes*, L. and also the quantities of nutrients that could conceivably be removed in plant biomass (Table I).

TABLE I

Constituent	Mean mineral nutrient composition of dried sample	Quantities of elements (kg/ha) that could be removed per year by continual culture
Ash ..	18·11%	..
Nitrogen ..	2·61%	1980
Phosphorus	0·43%	322
Sulphur ..	0·33%	248
Calcium ..	1·00%	750
Magnesium	1·05%	788
Potassium	4·25%	3188
Sodium ..	0·34%	255
Iron ..	250 ppm	19
Manganese	3940 ppm	296
Zinc ..	50 ppm	4
Copper ..	11 ppm	1

The harvested plants could be processed and fed to the animals or can be utilized for other purposes. In a similar manner *Eichhornia crassipes*, L. could be used to remove the nutrients from natural waters.

---

1. Archana Sharma, "Eradication and utilization of water hyacinth—A Review," *Curr. Sci.*, 1971, **40** (3), 51.
2. Claud E. Boyd, "Vascular aquatic plants for mineral nutrient removal from polluted waters," *Eco. Bot.*, 1970, **24** (1), 95.
3. Lawrence, J. King, *Weeds of the World, Biology and Control*, Leonard Hill, London, 1966.
4. Sculthorpe, C. D., *The Biology of Aquatic Vascular Plants*, Edward Arnold Ltd., London, 1967.

CORRELATION BETWEEN SOME QUALITY CHARACTERS AND PROTEIN DETERMINANTS IN BREAD WHEAT

T. R. SHARMA AND A. K. KAUL

Atomic Energy Laboratory, Indian Agricultural Research Institute, New Delhi-12

THE necessity of quick, reproducible and inexpensive methods of estimating protein quality in a cereal breeding programme, for quality, has been realized since long.[1] The need for such tests is essential in the early generation testing programmes when seed material available is usually small. Various micro tests, applicable in the early generations in a quality breeding programme in wheat, have been discussed by Kaul.[2]

In the present investigation 30 samples of wheat, selected on the basis of their dye-binding capacity (D.B.C.) value,[3] were picked up from 16 well-adapted varieties and 51 segregating lines in their F_3 and F_4 generations derived from various cross-combinations and grown in different agro-climatological conditions. The primary object of this experiment was to study the possible correlations between various protein determinants and other quality characteristics, and thereby select the most suitable method of protein estimation which is reliable, rapid and reproducible enough and thus useful in the early generations as a screening tool. In addition, the Pelshenke value (P.V.), Sedimentation value (S.V.) and Sulphur (S) content were also taken up for their possible role as the parameters of dough quality.

The macro D.B.C. was used for the estimation of protein quality. This method is based on the principle that the basic sites on protein molecule, namely, α-amino, ϵ-amino (lysine), β-imidazole (arginine) and γ-guanidine (histidine) form a complex with Acilane orange dye which is read at 470 mμ on a B and L Spectronic 20 colorimeter. The micro-Kjeldahl (Micro-N) and macro-Kjeldahl (Macro-N) methods were used for the determination of the nitrogen content of the flour samples.[4] The factor 5·7 was employed for the conversion of nitrogen values to respective protein figures. The protein values have been reported on a 10% constant moisture basis. Modified biuret method (B.V.) was used for the determination of nitrogen content.[5-6] Pelshenke values were obtained by using the method outlined by Cutler and Worzella[7] with some minor modifications as suggested by Kaul.[2] The technique outlined by Pinckney *et al.*[8] with a slight modification was followed for the determination of sedimentation value in the flour. The modification involved an increase in the concentration of lactic acid in the isopropyl alcohol-lactic acid reagent from 18% to 30% with corresponding decrease in the concentration of isopropyl alcohol from 20% to 17%. Total sulphur in the wheat flour was estimated by the methods outlined by Chesnin and Yien[9] and Shaw[10] and reported as mg sulphur/g of flour.

To obtain the thousand kernel weight (T.K.W.), 500 grains from each sample were counted and the weight of the same was doubled. All the samples were tempered to 14% moisture level, before milling. The tempered grain samples were milled on the micro-mill designed by Shoup *et al.*[11] The procedure outlined by Seeborg and Barmore[12] was employed for the evaluation of flour recovery (F.R.).

The data collected were analysed statistically on an electronic computer (I.B.M. 1620) following the procedures outlined by LeClerg *et al.*[13]

The mean, standard deviation, coefficient of variability and range for each character are presented in Table I. The P.V. which had the largest range also showed the highest coefficient of variability. The lowest range was obtained for D.B.C. whereas the lowest coefficient of variability was obtained for S content.

TABLE I

Means ($\bar{x}$), standard deviations (σ), coefficien of variability % (C.V.) and ranges for differen characters in 30 samples of wheat selected primarily on the basis of D.B.C.

Character*		$\bar{x}$	σ	C.V. (%)	Range
D.B.C.	..	0·222	0·02	9·0	0·095
Micro-N	..	12·59	2·11	16·7	7·1
Macro-N	..	12·83	2·07	16·1	7·1
B.V.	..	0·417	0·05	11·9	0·200
P.V.	..	163	49·47	30·3	217
T.K.W.	..	33·32	7·48	22·4	30·05
S V.	..	59·8	5·31	8·8	17
F.R.	..	71·4	3·84	5·3	17·5
S	..	1·91	0·10	5·2	1·30

* Please refer to the text for explanation of the abbreviations used.

The correlations obtained between the nin characters studied are presented in Table I Correlations between D.B.C., Micro-N, Macro-N and B.V. were all very high and highly signi

TABLE II

Correlation between different quality characters in 30 samples of wheat selected primarily on the basis of D.B.C.

Character	Micro-N	Macro-N	B.V.	P.V.	T.K.W.	S.V.	F.R.	S
D.B.C. ..	0·917†	0·934†	0·902†	0·443*	−0·407*	0·438*	−0·256	0·797†
Micro-N ..	..	0·950†	0·953†	0·420*	−0·566†	0·515†	−0·313	0·652†
Macro-N ..	..	..	0·914†	0·452*	−0·515†	0·595†	−0·302	0·734†
B.V. ..	..	..	..	0·425*	−0·542†	0·528†	−0·282	0·682†
P.V. ..	..	..	..	..	0·031	0·153	0·292	0·311
T.K.W. ..	..	..	..	..	..	−0·478†	0·629†	−0·185
S.V. ..		..	..	..	..	..	−0·495†	0·235
F.R. ..	..	..	..	..	..	..	..	−0·104

* Significant at 5% probability level † Significant at 1% probability level.

ficant in all combinations, indicating the potentialities of D.B.C. as a rapid screening device for protein content. The B.V. showed the highest correlation coefficient with Micro-N, suggesting its possible usefulness as a routine laboratory method for protein determination. The P.V. was positively and significantly correlated with all the four methods of protein determination, whereas S.V. was positively and highly significantly correlated with all but the D.B.C. value with which it was only significantly correlated. The P.V. was positively but non-significantly correlated with the other characters whereas S.V. was positively but non-significantly correlated with F.R. The T.K.W. was negatively and significantly correlated with D.B.C. value and highly significantly correlated with other methods of protein determination. It was negatively correlated with S, though non-significant. However, as expected, T.K.W. was positively and highly significantly correlated with F.R. The F.R. was negatively and non-significantly correlated with all the methods of protein estimation and S content in the flour. The S content was found to be highly significantly and positively correlated with protein content as determined by all the four methods.

The relationship of D.B.C. with B.V. and Macro-N is illustrated in Fig. 1.

The correlation studies among various determinants of quality have been conducted by many workers, since such studies help in the evaluation of breeding material.[14-16] The correlation between D.B.C. and nitrogen values described by macro-Kjeldahl and micro-Kjeldahl methods were 0·917 and 0·934, respectively. Mossberg[16] reported an r value of 0·767 in his studies. The present data confirms the usefulness of D.B.C. as a quick and reliable determinant of crude protein content. The correlation between D.B.C. and B.V. also being of high magnitude suggests high potentiality of B.V. as a routine laboratory method. However, time being a critical factor in the B.V. determination, its use as a rapid technique has limited potentialities in comparison to the D.B.C. technique.

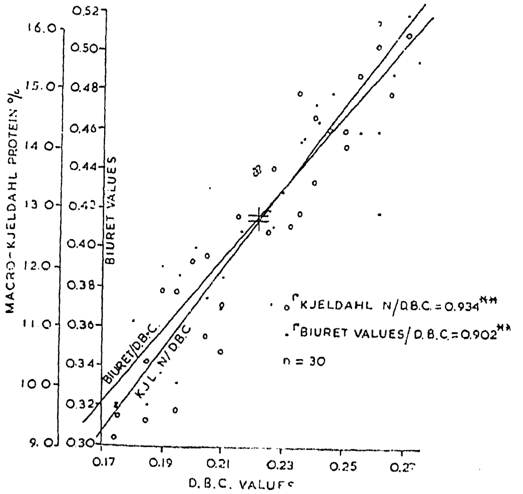


FIG. 1. Scatter diagram of relationship of D.B.C. with Biuret values and macro-Kjeldahl N values of 30 wheat samples.

The correlation of S.V. with all the four methods of protein determination was highly significant except that with the D.B.C. value, where it was only significant. This lower magnitude of correlation could be ascribed to the fact that D.B.C., being based on the basic amino-acids, may not reflect the gluten characteristics so very accurately. This was again confirmed in the correlation studies between D.B.C. and P.V.

The positive and significant correlation between sulphur and protein content alone could not be taken as an index for bread quality, since its correlation with S.V. and P.V. though positive was non-significant. From a similar study, Udy[17] concluded that more than the disulfide cross-links, dough quality is associated with the electrostatic forces prevalent in the gluten. Sullivan[18] has also emphasized the role of various binding forces, other than S-S, with reference to the dough-making properties.

The authors record their indebtedness to Dr. M. S. Swaminathan, Director, I.A.R.I., and Dr. H. K. Jain for their encouragement. The senior author is thankful to the I.A.R.I. for the financial assistance.

---

1. Kaul, A. K., Dhar, R. D. and Swaminathan, M. S., *Proc. FAO/IAEA. Symp. on Plant Protein Resources, Their Improvement Through the Use of Nuclear Techniques*, Vienna, 1970, p. 253.
2. —, *Ind. J. Genet.* 1969, **29**, 348.
3. —, Dhar, R. D. and Raghaviah, P., *J. Food Sci. Tech.*, 1970, **7**, 11.
4. Anonymous, *Cereal Laboratory Methods*, American Association of Cereal Chemists, St Paul, Minnesota, U.S.A., 1962, 7th Ed.
5. Pinckney, A. J., *Cereal Chem.*, 1949, **26**, 423.
6. Jennings, A. C., *Ibid*, 1961, **38**, 467.
7. Cutler, G. H. and Worzella, W. W., *J. Am. Soc. Agron.*, 1971, **34** (23), 1000.
8. Pinckney, A. J., Greenaway W. T. and Zeleny, L. *Cereal Chem.*, 1957, **34**, 16
9. Chesnin, L. and Yien, C. H., *Proc. Soil Sci. Soc. Amer.*, 1951, **15**, 149.
10. Shaw, W. M., *J. Agri. Food Chem.*, 1959, **7**, 843.
11. Shoup, N. H, Pell, K. K, Seeborg, E. F. and Barmore, M. A., *Cereal Chem.*, 1957, **34**, 296.
12. Seeborg, E. F. and Barmore, M. A., *Ibid.*, 1957, **34**, 299.
13. LeClerg, E. L., Leonard. W. H. and Clark, A. J., *Field Plot Technique*, Burgess Publishing Co., Minneapolis, Minn., 1962
14. Zeleny, L., *Cereal Chem.*, 1947, **24**, 465.
15. Sunderman, D. W., Wise, M. and Snned, E. M., *Crop. Sci.*, 1965, **5**, 537.
16. Mossberg, R., *Proc. FAO/IAEA Panel on New Approaches to Breeding for Plant Protein Improvement*, Sweden, 1969, p. 151.
17. Udy, D. C., *Cereal Chem.*, 1953, **30**, 288.
18. Sullivan, B., *Cereal Sci.*, Today, **1965**, **10**, 338.

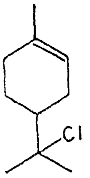
LIMONENE MONOHYDROCHLORIDE—ITS NATURE AND REACTIONS

N. V. MURALEEDHARAN AND J. VERGHESE

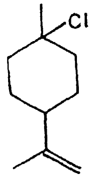
Department of Chemistry, Christian Medical College, Vellore-2

LIMONENE monohydrochloride is easily got when dry hydrogen chloride is led into a solution of the terpene in carbon disulphide.[1] If the monohydrochloride is homogeneous, then formula (I) must represent this derivative since on hydrolysis with 2% aq. potassium hydroxide[2] and reduction with sodium/ethanol[3] it yielded α-terpineol and *p*-menth-1-ene respectively; the hydrolysis also afforded hydrocarbon(s) of unspecified nature. In keeping with this structural assignment, the monohydrochloride furnished a nitrosate, m.p. 108-109° and nitrosochloride, m.p. 109°.[4]

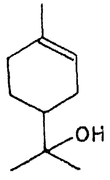
We secured by hydrochlorinating (+)-limonene [glc : single peak, $(\alpha)_D^{30} + 124° 9'$] a monohydrochloride. $C_{10}H_{17}Cl$, b.p. 94-99°/11 mm. $(\alpha)_D \pm 0°$, i.r. (neat): 1379, 1360 cm^{-1} [$\rangle C(CH_3)_2$],[5a] 890 cm^{-1} ($\rangle C = CH_2$), 805 cm^{-1} ($\rangle C = CH-$).[5b] 763 cm^{-1} (C-Cl).[5c] The i.r. absorptions revealed that the monohydrochloride (I) is admixed with the isomer (II).



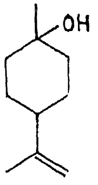
I



II



III

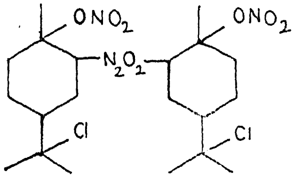


IV

Hydroxylation of the monohydrochloride with 2% aq. potassium hydroxide at 90° gave an oil which included 27% hydrocarbons and 64% alcohols. Glc analysis proved that the hydrocarbon portion consisted essentially of dipentene (97%, tetrabromide, m.p. and cross m.p. 124°): the alcohols were made up of *dl*-α-terpineol (III) (91%, nitrosochloride, m.p. and cross m.p. 120-121°) and β-terpineol (IV) (7·4%). Further evidence supporting the presence of these alcohols were available from the i.r. (neat) data. In addition to hydroxyl absorption at 3334 cm^{-1}, the absorptions in favour of α-terpineol were 840 cm^{-1} ($\rangle C = CH-$), 1368, 1360 cm^{-1} [$\rangle C(CH_3)_2$] and of β-terpineol 1640 and 890 cm^{-1} ($\rangle C = CH_2$).[6] The formation of the two alcohols supports the binary nature of the monohydrochloride.

Following the directions of Wallach,[1] we were able to get from the monohydrochloride a dimeric nitrosate $(C_{10}H_{17}Cl.\ N_2O_4)_2$, m.p. 115°, i.r. (KBr): 750 cm^{-1} (C–Cl),[5c] 1200, 1220 cm^{-1} (N = O stretching),[7] 1168, 1220 cm^{-1} (nitrosodimer),[8] 1625 cm^{-1} (ONO_2),[5d] 1455 cm^{-1} ($\rangle C\langle {}^H_H$), 1365, 1375 cm^{-1} [$\rangle C(CH_3)_2$][5a] and 990 cm^{-1} (cyclohexane ring).[5c] Structure (V), now tentatively proposed for the nitrosate, would accommodate the moieties visible in the i.r. spectrum.

Two other derivatives were procured from the monohydrochloride, *viz.*, nitrosochloride $(C_{10}H_{17}Cl.NOCl)_3$, m.p. 109° ; i.r. (KBr): 750 cm^{-1} (C-Cl),[5c] 1198, 1220 cm^{-1} (N = O stretching),[7] 1160, 1220, 1266 cm^{-1} (nitrosodimer),[8] 1455 cm^{-1} $(\rangle C\langle^{H}_{H})$, 1360, 1380 cm^{-1} $[\rangle^{a} C(CH_3)_2]$,[5e] 980 cm^{-1} (cyclohexane ring)[5c] and nitrosobromide, $(C_{10}H_{17}Cl.NOBr)_3$, m.p. 120°, i.r. (KBr): 742 cm^{-1} (C-Br),[5f] 1180, 1200 cm^{-1} (N = O stretching),[7] 1155, 1200, 1260 cm^{-1} (nitrosodimer),[8] 1450 cm^{-1} $(\rangle C\langle^{H}_{H})$, 1360, 1380 cm^{-1} $[\rangle C(CH_3)_2]$,[5a] 988 cm^{-1} (cyclohexane ring).[5c] These data do not offer complete solution to the formulae of these compounds. Further work is in progress.



V

EXPERIMENTAL

Limonene Monohydrochloride.—Under anhydrous conditions, hydrogen chloride was bubbled for 6 hr through a chilled solution of limonene [glc : single peak, $(\alpha)^{30}_{D} + 124° 9'$] (105 g) dissolved in carbon disulphide (125 ml). Usual work-up afforded the crude oily monohydrochloride (150 g), n^{20}_{D} 1·4888. Distillation of the oil in Todd column at a reflux ratio 25 : 1 gave the desired monohydrochloride, b.p. 94-99°/11 mm (53 g, 36·4%), n^{20}_{D} 1·4815, d^{30}_{30} 0·9656, $(\alpha)^{30}_{D} \pm 0°$ (CHCl$_3$, c 10·5). Anal. calcd. for $C_{10}H_{17}Cl$: Cl 29·77%. Found : Cl 29·4%. I.r. absorptions : as described above.

Hydroxylation of Limonene Monohydrochloride.—Limonene monohydrochloride (23 g) was agitated (magnet-bar) with 2% aq. KOH (1200 ml) at 90° for 5 hr and the reaction mixture steam-distilled. The oil received after drying (Na$_2$SO$_4$), (17·5 g, n^{20}_{D} 1·4795), when subjected to precise fractionation in Todd column at reflux ratio 25 : 1 gave fraction (1), b.p. 109-114°/100 mm (4·7 g, 27%), n^{20}_{D} 1·4771, $(\alpha)^{20}_{D} \pm 0°$ (CHCl$_3$, c 2·5) and fraction (2), b.p. 113-120°/25 mm (10·9 g, 64%), n^{20}_{D} 1·4823, $(\alpha)^{20}_{D} \pm 0°$ (CHCl$_3$, c 6·5). Gas chromatographic analysis on column SE-30 (Aerograph A 90-P$_3$ instrument) showed that fraction (1) contained dipentene (97%) and fraction (2) α-terpineol (91%) and β-terpineol (7·4%). Fraction (1) (2·5 g) on bromination[9] gave dipentene tetrabromide (2 g), m.p. and mixed m.p. 124°. Nitrosochlorination[2,10] of fraction (2) (1·8 g) afforded *dl*-α-terpineol nitrosochloride (~ 450 mg), m.p. and mixed m.p. 120-121°.

Limonene Monohydrochloride Nitrosate.—From the monohydrochloride (3·5 g) we obtained[1] the nitrosate (1·3 g), m.p. 115°. Anal. calcd. for $C_{10}H_{17}ClN_2O_4$: C 45·38 ; H 6·47 ; N 10·59 ; Cl 13·4%. Mol. wt. 264·69 (monomeric). Found : C 45·89 ; H 6·48 ; N 11·19 ; Cl 13·20%. Mol. wt. 512 (osmometric). I.R. absorptions : as described above.

Limonene Monohydrochloride Nitrosochloride.—Following the literature method,[4] the monohydrochloride (2·4 g) afforded the nitrosochloride derivative (~ 400 mg), m.p. 109°. Anal. calcd. for $C_{10}H_{17}NOCl_2$: C 50·43 ; H 7·19 ; N 5·88 ; Cl 29·77%. Mol. wt. 238·15 (monomeric). Found : C 50·48 ; H 7·11 ; N 5·70 ; Cl 29·40%. Mol. wt. 705 (osmometric). I.r. absorptions : as described above.

Limonene Monohydrochloride Nitrosobromide.—An ice-cold solution of hydrobromic acid (48%, 2·5 ml) in ethanol (3·5 ml) was introduced dropwise, with stirring, to a chilled solution of a mixture of limonene monohydrochloride (2 g), ethanol (3·5 ml) and amyl nitrite (3·5 ml). After the addition of methyl alcohol (10 ml), the reaction mixture was refrigerated overnight. The crude derivative was collected by suction filtration, washed with ice-cold methanol (10 ml) and purified twice by precipitating from chloroform with cold methanol (~ 190 mg), m.p. 120°. Anal. calcd. for $C_{10}H_{17}NOClBr$: C 42·5 ; H 6·06 ; N 4·95%. Mol. wt. 282·6 (monomeric). Found : C 42·45 ; H 6·03 ; N 4·9%. Mol. wt. 879 (osmometric). I.r. absorptions : as described above.

---

1. Wallach O., *Annalen*, 1892, **270**, 171.
2. —, *Ibid.*, 1906, **350**, 141.
3. Semmler, F. W., *Chem. Ber.*, 1903, **36**, 1033.
4. Wallach, O., *Annalen*, 1888, **245**, 241.
5. Bellamy, L. J., *The Infra-red Spectra of Complex Molecules*. John Wiley & Sons, Inc., New York, 1966, (*a*) p. 13, (*b*) p. 34, (*c*) p. 330, (*d*) p. 301, (*e*) p. 31, (*f*) p. 332.
6. Mitzner, B. M. and Lemberg, S., *Amer. Per. and Cosmetics*, 1966, **81**, 25.
7. Ponder, B. W., Walton, T. B. and Pollock, W., *J. Org. Chem.*, 1968, **33**, 2165.
8. Merrit, B. F. and Ruff, J. K., *J. Amer. Chem. Soc.*, 1964, **86**, 1393.
9. Verghese, J., *J. Ind. Chem. Soc.*, 1960, **37**, 262.
10. Muraleedharan, N. V. and Verghese, J., *Perfumery Essent Oil Record*, 1968, **59**, 275.

LETTERS TO THE EDITOR

Cl^{35} PURE QUADRUPOLE RESONANCE IN CERTAIN ORGANIC SOLIDS

USING a frequency-modulated self-quenching super regenerative nuclear quadrupole resonance spectrometer chlorine nuclear quadrupole resonances have been observed at room temperature (28° C) in (1) 2-2-dichloro acetamide, (2) *m*-chloro acetanilide, (3) 2-4-dichloro phenol, (4) *o*-chloro aceto acetanilide, and (5) *p*-chloro aceto acetanilide.

Frequencies were measured using a BC-221 frequency meter (125 Kc to 20 Mc/sec) by superimposing the first harmonic of the signal with the central component of the resonance line. The estimated error in frequency is less than ± 10 Kc/sec.

In the first four compounds, resonance lines were observed previously only at liquid nitrogen temperature (77° K) but not at room temperatures. For the fifth compound, no resonance line was observed earlier at any temperature. In Table I, the frequencies of the resonance lines observed at the liquid nitrogen and the room temperatures are compared for the five compounds.

TABLE I

S. No.	Compound	Resonance frequency for Cl^{35} at 28° C in Mc/sec	Literature value for Cl^{35} at 77° K in Mc/sec.
1	2, 2-Dichloro acetamide	35·173	37·238[1]
		35·708	37·750
2	*m*-Chloro acetanilide	34·103	34·735[2]
3	2, 4-Dichloro phenol	34·568	34·995[3]
		34·623	35·032
			35·214
			35·422
			35·679
			35·898
4	*o*-Chloro aceto acetanilide	34·508	35·049[4]
5	*p*-Chloro aceto acetanilide	33·889	34·620

In 2, 2-dichloro acetamide, two lines are observed both at room temperature (28° C) and at liquid nitrogen temperature. In 2, 4-dichloro phenol, six lines are observed at 77° K but only two at room temperature. As the two lines in these compounds are too close together to be attributed to the two Cl isotopes, they can be taken as due to Cl^{35} only, at two inequivalent sites. In the rest of the three compounds, only single lines are observed.

The authors are deeply indebted to Dr. K. V. J. Rao, Reader in Chemistry, for his kind help, and to the UGC for the financial assistance to one of them (P. V.).

Solid-State Phys. Labs., P. VENKATACHARYULU.
AUPG Centre, D. PREMASWARUP.
Guntur-5, *January* 27, 1971.

---

1. McCall, D., *J. Chem. Phys.*, 1953, **21**, 1300.
2. Bray, P., *Ibid.*, 1957, **27**, 551.
3. Biedenkapp, D. and Alarish Weiss, *Ibid.*, 1968, **49**, 3933.
4. Bray, P., *Ibid.*, 1955, **23**, 220.

PHASE STUDIES IN THE SYSTEM Bi_2MoO_6-La_2MoO_6

THE structure of natural Koechlinite[1] and La_2MoO_6[2] has been reported in the literature but the phase studies of the present system has not been investigated so far. In this note, the preparation and properties in the binary system Bi_2MoO_6-La_2MoO_6 are reported.

Bi_2MoO_6 and La_2MoO_6 were prepared by the high temperature solid-state reaction between the respective oxides (800° C for Bi compound and 1200° C for La compound) for six hours. X-ray diagrams were taken on a 14 cm diameter Debye-Scherrer camera using Ni filtered Cu radiation. The results are shown in Table I.

TABLE I

Phase studies in the system Bi_2MoO_6-La_2MoO_6

S. No.	Composition	Phases present
1	Bi_2MoO_6	Koechlinite orthorhombic $a_0 = 5 \cdot 5$ Å, $b_0 = 5 \cdot 47$ Å, $c_0 = 16 \cdot 21$ Å
2	$Bi_{1 \cdot 6}La_{0 \cdot 4}MoO_6$	Koechlinite $a_0 = 5 \cdot 47$ Å, $b_0 = 5 \cdot 45$ Å, $c_0 = 16 \cdot 19$ Å
3	$Bi_{1 \cdot 2}La_{0 \cdot 8}MoO_6$	Koechlinite $a_0 = 5 \cdot 43$ Å, $b_0 = 5 \cdot 39$ Å $c_0 = 16 \cdot 15$ Å
4	$Bi_{0 \cdot 8}La_{1 \cdot 2}MoO_6$	Koechlinite + La_2MoO_6 $a_0 = 5 \cdot 2$ Å, $b_0 = 5 \cdot 31$ Å, $c_0 = 16 \cdot 1$ Å
5	$Bi_{0 \cdot 4}La_{1 \cdot 6}MoO_6$	Koechlinite + La_2MoO_6, $a_0 = 4 \cdot 9$ Å, $b_0 = 5 \cdot 2$ Å, $c_0 = 16$ Å
6	La_2MoO_6	Tetragonal $a_T = 4 \cdot 1$ Å, $c_T = 15 \cdot 96$ Å

It is seen that as small as 10 mole % Bi^{3+} at the A site results in a Koechlinite phase. On introducing more Bi^{3+}, this phase predominates and at a concentration of 60 mole % of Bi^{3+} the La_2MoO_6 phase completely disappears. It can also be seen that the Koechlinite phase exists for a smaller radius ratio of A/B ($Bi^{3+} = 0{\cdot}93$ Å, $La^{3+} = 1{\cdot}14$ Å and $Mo^{6+} = 0{\cdot}69$ Å).[3] From ionic considerations, it would appear that the Bi^{3+} compound should have a smaller unit cell but one observes that the Koechlinite phase is considerably elongated along the *c*-axis in comparison to La_2MoO_6 (tetragonal). This may be clearly understood if one considers the structure of Bi_2MoO_6 which consists of alternate layers of MoO_4 and Bi_2O_2 perpendicular to the *c*-axis. Now, if the outer electron pair in Bi^{3+} ion ($6s^2$) is supposed to lie on the apex of the tetragonal BiO_4 pyramid, it would cause an extra repulsion between MoO_4 and Bi_2O_2 layers since the apex of the BiO_4 pyramid is directed towards the MoO_4 layer. This repulsion is presumed to be responsible for elongation observed along the *c*-axis.

Dept. of Physical and Solid-State Chemistry,
Institute of Science,
Nagpur, *December* 21, 1970.

A. R. VYAWAHARE.
V. S. CHINCHOLKAR.

---

1. Zemann, Z., *Structure Reports*, 1956, **20**, 449.
2. Silren, L. G. and Lundborg, K , *Z. Anorg. Chem.*, 1943, **252**, 2.
3. Ahrens, L. H., *Geochim et Cosmochim Acta*, 1952, **2**, 155.

ELASTIC STUDIES IN LEPTYNITES

THERE are no data on the elastic moduli of leptynites of Visakhapatnam where they are found to occur largely along with khondalites and charnockites, on which, however, data are available in literature. In fact, leptynites are as useful as khondalites and charnockites of Visakhapatnam and are recognised as a hybrid formation between the two. It is an acidic rock usually occurring in the granitic layers of the crust, thus rendering it associated with quartz and felspar. It is felt that the elastic data of this rock will be as useful as that for khondalites or charnockites.

Six good samples of leptynites were collected from the Waltair Uplands area in Visakhapatnam. The collection exhibits no banded structure. The rocks are in general coarse-grained, medium-coloured and look almost identical.

Employing the continuous wave ultrasonic rotating plate method[1] the longitudinal and transverse elastic wave velocities have been determined in the six chosen samples, and thence their Young's and rigidity moduli and Poisson's ratio have been calculated. Further, the samples have been analysed for their quartz and felspar contents, including both the orthoclase felspar and perthite felspar.

Table I contains the data of the analysis. Table II contains the elastic data.

TABLE I

Quartz and felspar contents in leptynites of Visakhapatnam

Sample No.	Density gm/c.c.	Quartz	Felspar
1	2·70	17	40
2	2·78	15	42
3	2·95	13	42
4	3·00	9	49
5	3·10	7	35
6	3·20	7	62

TABLE II

Elastic velocities and moduli in leptynites of Visakhapatnam

Sample No.	V_L	V_T	Y	n	σ
1	5463	2841	5·733	2·230	0·273
2	5490	2832	5·879	2·229	0·318
3	5606	2861	6·395	2·415	0·324
4	5690	2872	6·577	2·475	0·328
5	5701	2875	6·823	2·564	0·330
6	5734	2882	7·074	2·658	0·330

In Table II, longitudinal velocity (V_L), and transverse velocity (V_T) are in m/sec, Young's modulus Y and rigidity modulus n are in 10^{11} dynes/cm^2 and σ is Poisson's ratio.

It may be noted that the elastic moduli remain reasonably constant for the different specimens. Any slight variation in the moduli among the different specimens may be qualitatively attributed to their respective quartz and felspar contents through their effect on density, since the specimens chosen are free from any banded structure.

Dept. of Engg. Physics,
College of Engineering,
Andhra University,
Waltair, *January* 1, 1971.

T. VISWESWAR.
BH. KRISHNAMURTY.

---

1. Krishnamurty, T. B. R. and Krishnamurty, Bh., *Journal of the Indian Geophysical Union*, 1964, **1** (4), 245.

SEPARATION OF PHENOL-FORMALDEHYDE REACTION PRODUCTS BY REVERSED PHASE CHROMATOGRAPHY

SEVERAL paper chromatographic methods are known[2,3] for the separation of phenol-formaldehyde reaction products, *viz.*, methylol phenols and dihydroxy diphenyl methanes (DPMs). But so far no reversed phase chromatographic method has been reported, probably for lack of good solid supports. However, recently, Teflon 6, a variety of tetrafluoroethylene, has been used by Fritz and Hedrick[4,5] for the separation of monohydric phenols and amines. In the present work, binary mixtures of phenol, methylol phenols and DPMs are separated by reversed phase chromatography on a Teflon 6 column. The stationary phase is the organic layer and the mobile phase the aqueous layer of a three-component system of water, cyclohexane and cyclohexanol (250 : 30 : 10 v/v).

Reagents and Apparatus.—The solvents and phenol used were B.D.H. analytical grade. Methylol phenols and DPMs were synthesised by the well-known methods. Teflon 6 (Du Pont 70-80 mesh) was obtained from Analytical Engineering Labs., Hamden, Conn., U.S.A. It was washed with acetone and diethyl ether and air-dried before use. Glass columns (1 × 25 cm) with glass wool plugs, to support the packing, were used. Water, cyclohexane and cyclohexanol (250 : 30 : 10 v/v) were mixed in a separatory funnel and the aqueous and organic layers separated. The column was filled with the organic layer and the dried inert support added till the desired height was obtained. The excess stationary phase was then replaced by the mobile phase, *i.e.*, the aqueous layer of the solvent mixture.

Separation and Analysis.—100 mg samples of the compounds to be separated were weighed out into a 50 ml standard flask, dissolved and made up using water. Aliquots (1 ml) from this stock solution were used for separation. The mobile phase was added continuously from a separatory funnel at a steady flow rate of 1 ml per minute and 1 ml portions were collected in calibrated test-tubes. To each of these were added 2 ml of a 2·5% solution of sodium nitrite and 5 ml of a 2% solution of p-nitroaniline and finally 5 ml of 1·5 N NaOH. The absorbance of the resulting red solutions were measured in a Bosch and Lomb Spectronic 20 spectrophotometer at 475 nm. The separations obtained in the case of three typical pairs are shown in Fig. 1. The retention volumes of the pure substances were determined from separate experiments and using these values the components of the mixtures were identified. o-Methylol phenol has the least retention volume followed by phenol and DPMs.

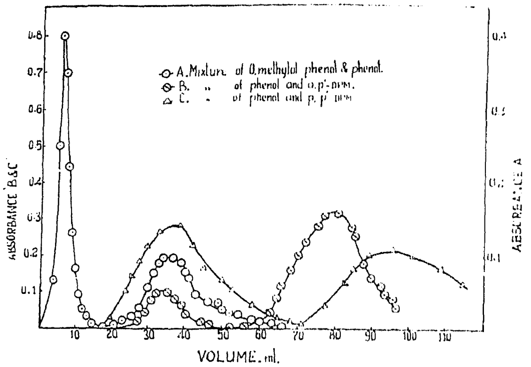


FIG. 1. Separation of phenol-formaldehyde reaction products.

Dept. of Chemistry,
University of Kerala,
Trivandrum-1, *November* 11, 1970.

P. C. THARIAN.
D. JOSEPH FRANCIS.[1]

---

1. To whom communications are to be addressed at Institut für physikalische Chemie der Universität, Tübingen, Wilhelmstrasse-56, BRD.
2. Freeman, J. H., *Anal. Chem.*, 1952, **24**, 955, 2001.
3. Yeddanapalli, L. M. and Kuriakose, A. K., *J. Sci. and Ind. Res.*, 1952, **18 B**, 467.
4. Fritz, J. S. and Hedrick, C. E., *Anal. Chem.*, 1965, **37**, 1015.
5. Hedrick, C. E. *Ibid.*, 1965, **37**, 1044

A NEW SYNTHESIS OF SYMMETRICAL DIBENZYL THIOUREA

SYMMETRICAL dibenzyl thiourea was first isolated from the bark of *Crataeva roxburghii*[1] and recently from the air-dried seeds of *Salvadora oleoides*.[2] It was synthesised earlier from urea and benzyl amine.[3] An alternative synthesis has now been carried out by treating excess of benzyl amine and carbon disulfide with H_2O_2 in the presence of diethyl amine. The reaction goes smoothly and the product is only symmetrical dibenzyl thiourea. It involves first formation of benzyl isothiocyanate and hydrogen sulfide in the usual way. The latter is oxidised by H_2O_2 so as to allow the equilibrium to go in the forward direction. Finally, benzyl isothiocyanate condenses with excess benzyl amine to give dibenzyl thiourea. Recently, this method has been used for the preparation of *N-N* diphenyl thiourea from aniline.[4]

Sym. Dibenzyl Thiourea.—Hydrogen peroxide (30% ml, 4 ml) was added gradually to a stirred mixture of benzylamine (3·2 ml), carbondisulfide (3·6 ml) and diethyl amine (2 ml) at 0°. After five minutes, the semi-solid was separated from the mother liquor and triturated with warm acetone several times to leave behind sulfur. The acetone solution was evaporated to dryness and the residue crystallised twice from methanol, when symmetrical dibenzyl thiourea separated in colourless crystals (3·1 g), m.p. 147-48° alone or when mixed with an authentic sample; T.L.C. in chloroform : methanol (97 : 3) and spraying with 50% diluted H_2SO_4 showed a single spot (R_f 0·65).

Dept. of Chemistry, MANJU CHATURVEDI.
University of Jammu, A. C. JAIN.
Jammu-1, *December* 24, 1970.

1. Chakravorty, R. N., *Chem. Abst.*, 1952, **46**, 3221.
2. Chopra, G. R., Jain. A. C. and Seshadri, T. R., *Curr. Sci.*, 1968, **37**, 121.
3. Mistri, S. M. and Guha, P. C., *J. Ind. Chem. Soc.*, 1930, **7**, 793.
4. Johar, G. S., Agarwala, U. S. and Rao, B. P., *Ind. J. Chem.*, 1970, **8**, 759.

POLYPHENOLS OF THE SEEDCOAT OF *MANGIFERA INDICA*

IN continuation of our earlier work on the flowers, leaves and the seedcoat (testa) of *Anacardium occidentale* Linn.[1,2] (cashewnut) reported to contain ethyl gallate and catechins respectively and the record[3] of the presence of ethyl gallate in the panicles of *Mangifera indica* Linn. belonging to the same family *Anacardiaceae* under subgroup *Mangifereae*, we have examined the seedcoat of *M. indica*, and our results are recorded here.

The dry seedcoat on the kernels of mature mango fruits was extracted with ether and acetone in succession. The ether extract on concentration yielded a light yellow residue which was digested with petroleum ether (40-60°); the petrol-soluble fraction answered tests for sterols and on further working up yielded β-sitosterol. The petrol-insoluble portion was found to be a mixture, and on recrystallisation from hot water yielded colourless crystals, m.p. 96-98° (yield, 1·0%). This was identified as (+)-catechin by colour reactions, optical activity, its acetyl derivative, co-chromatography and m.m.p. determination with authentic compound.[2] The mother liquor after the separation of (+)-catechin was layered with an equal volume of benzene and kept in the ice chest for about two weeks, when some colourless solid separated. This was twice crystallised from hot moist benzene to yield colourless needles, m.p. 210-212°, optically inactive and answering all the tests for catechins. On acetylation, it yielded a crystalline derivative, m.p. 160-162°. The compound was identified as (±)-catechin. The whole of the aqueous mother liquor was further concentrated and studied by PC and TLC, and found to contain (−) epicatechin and ethyl gallate (co-chromatography with authentic samples).

The acetone extract contained leucocyanidin, identified by R_f, colour reactions and conversion to cyanidin chloride.

The marc left after ether and acetone extractions was extracted with hot methanol to yield some reddish-brown residue which answered tests for gallotannins, whose presence is known in *Anacardiaceae*.[4]

It is interesting from the point of view of molecular taxonomy that the same components (ethyl gallate, catechins and leucocyanidin) are present in both *A. occidentale* and *M. indica* which belong to the same subgroup, *Mangifereae*. However, they differ from the other subgroup members of *Spondieae* (containing ellagic acid[5]) and *Rhoideae* (containing myricetin[6]) of the same family.

The presence of compounds having a pyrogallol system seems to be a common feature of this family. Further, the earlier observation[6] that myricetin is a characteristic flavone of *Anacardiaceae* family as such is not supported by the present work, and it is to be considered with limitation to the subgroup *Rhoideae*.

Our thanks are due to the Principal, J.I.P.M.E.R., for encouragement.

Dept. of Chemistry, S. SANKARA SUBRAMANIAN.
J.I.P.M.E.R., A. G. R. NAIR.
Pondicherry-6, *December* 29, 1970.

1. Subramanian, S. S., Joseph, K. J. and Nair, A. G. R., *Phytochem*, 1969, **8**, **674**.
2. — and Nair, A. G. R., *Curr. Sci*, 1969, **38**, 494.
3. Singh, L. B. and Bose, J. L., *J. Sci. and Ind. Res.*, 1961, **20 B**, 296
4. King, H. G. C. and White, T., *Proc. Chem. Soc.*, 1957, p. 341.
5. Nair, A. G. R., Subramanian, S. S. and Sreedharan, K., *Curr. Sci.*, 1963, **32**, 115.
6. Reznik, V. H. and Egger, K., *Z. Naturforsch.*, 1960, **15**, 247.

RETARDING EFFECT OF DESICCATION ON NITROGEN MINERALIZATION IN ORGANIC MANURES

For the greater part, the nitrogen in organic manures of animal or vegetable origin is complex in chemical nature due to its presence in the form of proteinaceous compounds which are largely insoluble in water. If such nitrogen is to be transformed to mineral forms which are easily available to plants, the parent materials must be subjected to the agencies of decomposition in the soil. The actual amount of mineral nitrogen liberated when an organic material is decomposing depends on several factors. Generally, for a given carbon and nitrogen content in the decomposing material, the amount of mineral nitrogen in the soil increases if it contains simpler nitrogenous compounds. On the other hand, if it contains simpler easily decomposable carbon there will be immobilisation of soil mineral nitrogen.[3] However, in a discussion on green manuring, Joffe[1] pointed out that drying of a green manuring material may retard its nitrogen mineralisation rate. The main effect of drying was attributed to be due to enhanced irreversibility of the organic colloidal matter due to desiccation which becomes more resistant to further microbial attack. As far as the authors are aware, there has been no work in the past to see the effect of drying on the nitrogen mineralisation in animal organic manures.

The present investigation is, therefore, undertaken to see the effect of drying on the quantity of nitrogen mineralised in an animal manure, *viz.*, dung spent-slurry. The dung spent-slurry is produced after anaerobic fermentation of cattle dung in a biogas plant.[2] During its preparation, this manure is never subjected to drying, since fresh cattle dung, in the form of a suspension in water, is fed in the fermentation tank of the biogas plant and taken out after one month of anaerobic fermentation in the liquid form. The liquid spent-slurry used in this experiment contained 1·803% N, 35·21% C, and thus has a C/N ratio of 19 : 42. The drying of the liquid spent-slurry was effected by exposing it in sun in big containers. The drying has not affected the composition of spent-slurry.

To evaluate the effect of drying on mineralised nitrogen nitrification experiments were carried out by addition of liquid and sun-dried spent-slurry at the rate of 30 mg of nitrogen per 100 g of soil and incubated at 60% moisture-holding capacity of soil at room temperature. The total mineralised nitrogen was determined at the end of six months. The results are given in Table I.

Table I

Total mineralised nitrogen ($NH_3 + NO_3$) *after six months of incubation*

	Mineralised nitrogen in mg/100 g of soil		Nitrogen mineralised from manure (in %)
	Total mineralised	Excess over control	
Soil alone (control)	3·19	..	..
Soil + liquid slurry	7·64	4·45	14·84
Soil + dried slurry	4·16	0·96	3·22

The results show that the sun-drying of spent-slurry has drastically reduced the rate of nitrogen mineralisation, because in case of liquid slurry, the rate of mineralisation is about four times more than that of dried slurry. The reason may be, as given above, irreversible desiccation of organic colloids of the manure on sun-drying and thus their increased resistance to subsequent microbial decomposition in soil. This leads to the conclusion that apart from the chemical composition of an organic manure, the treatment given to it before applying to soil should also be taken into consideration while evaluating its nitrogen supplying power to growing plants. The practical implication of this result is that in order to exploit the full potential of the benefits that can be obtained from organic manures for better and bigger crops, they should never be subjected to drying before applying.

Division of Soil Science
and Agric. Chemistry,
Ind. Agric. Res. Inst.,
New Delhi, *December* 30, 1970.

R. D. LAURA.*
M. A. IDNANI.

---

* Present address: Laboratoire de Physico-Chimie Minérale, Institut des Sciences de la Terre, 42 de Croylaan, **3030**, Heverlee, Louvain, Belgium.

1. Joffe, J. S., *Adv. Agron.*, 1955, **7**, **142**.
2. Acharya, C. N., *Indian Coun. Agric. Res.; Res. Rev. Ser. Bull.*, New Delhi. 1952, **2**.
3. Rubins, E. J. and Bear, F. E, *Soil Sci.*, 1942, **54**, 411.

IDENTIFICATION OF 'METHYL ANGOLENSATE' IN THE BARK OF *SOYMIDA FEBRIFUGA* A. JUSS

Soymida febrifuga (Family Meliaceae) is an indigenous tree, commonly found in dry forests of W. Peninsula[1] and called *Rohini* in Sanskrit. The decoction of inner bark of the tree is reported to be in use as an anti-cancer remedy. The bark of the tree was referred to one of us (T. B. P.) for systematic investigation by Dr. I. M. Patel from Gujarat State. Alcoholic extractives of the bark have been found to possess tumour inhibitory activity against transplantable rat carcinosarcoma and rat Yoshida sarcoma (ascites).

Petroleum ether extract of the bark of *S. febrifuga* has yielded a sterol (I), m.p. 135-36°, compound (II), m.p. 257° (decomp.) and compound (III), m.p. 203-04°. Carbon-hydrogen analysis of the compound (III) and its molecular weight (470) by mass spectrum indicated for it the molecular formula, $C_{27}H_{34}O_7$ (Found : C, 69·0 ; H, 7·18 ; $C_{27}H_{34}O_7$ requires C, 68·9 ; H, 7·3%). The compound (III) formed 2 : 4-dinitrophenylhydrazone, m.p. 266-67° (decomp.) (Found: N, 8·25 ; $C_{33}H_{38}N_4O_{10}$ requires N, 8·6%). Mild alkali hydrolysis of (III) yielded an acid, m.p. 254-55° and reduction of (III) in alcoholic solution with Raney Nickel as catalyst, gave a product, m.p. 196-97°.

The UV absorption of (III) showed λ^{E}_{max} at 212 mμ (log ϵ 3·87). IR spectrum of (III) exhibited bands at $\nu_{max.}$ 3120, 3080, 1500 and 872 cm^{-1} (furan); 1740, 1050 and 1020 cm^{-1} (methyl ester, δ-lactones) and 1720 cm^{-1} (cyclohexanone). NMR spectrum of (III) showed presence of four methyl groups : two of them angular methyls as singlets at 53 cps (0·88 δ) and at 58 cps (0·96 δ); while other two gem-dimethyls appearing as singlets at 64 cps (1·06 δ) and at 73 cps (1·21 δ) respectively. Methyl ester appears as a singlet at 224 cps (3·70 δ). The protons of the furan ring appear as singlet (1 H) at 385 cps (6·41 δ) and broad singlet (2 H) at 445 cps (7·41 δ).

The chemical reactions and spectral data of the compound (III) indicated it to be methyl angolensate (ring B-seco tetranor-tetracyclic tri-terpene)[2,3] occurring in several species of the family 'Meliaceae'.[4] The melting points of the 2 : 4-dinitrophenylhydrazone and the reduction product of (III) closely agreed with those of the corresponding derivatives (m.p. 261-64° and m.p. 186-89° respectively) of the methyl angolensate, reported by earlier workers.[2] The identity of the compound (III) was confirmed by mixed melting point with an authentic sample of methyl angolensate which remained undepressed and by their superimposable IR spectra.

Ether extract of the bark of *S. febrifuga* has yielded a steryl glycoside, m.p. 290-95° (decomp.).

We are indebted to Dr. W. R. Chan, University of West Indies, Jamaica, for a generous sample of methyl angolensate, and to Dr. I. M. Patel, Junagadh, Gujarat State, for the supply of 'Rohini' bark.

Chemotherapy Section, R. Y. AMBAYE.
Cancer Res. Inst., M. A. INDAP.
Tata Memorial Centre, T. B. PANSE.
Parel, Bombay-12, *December* 28, 1970.

---

1. Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glossary of Indian Medicinal Plants*, CSIR, New Delhi, 1956, p. 232.
2. Bevan, C. W. L., Powell, J. W., Taylor, D. A. H., Halsall, T. G., Toft, P. and Welford, M., *J. Chem. Soc.*, 1967, p. 163.
3. Chan, W. R., Magnus, K. E. and Mootoo, B. S., *Ibid.*, 1967, p. 171.
4. Bevan, C. W. L., Ekong, D. E. U. and Taylor, D. A. H., *Nature*, 1965, **206**, 1323.

ABSORPTION OF GLUCOSE IN THE GASTROINTESTINAL TRACT OF BIRDS

KNOWLEDGE on the absorption of the products of enzymatic hydrolysis in the alimentary canal of the vertebrates is restricted only to certain mammals and a few birds. Active absorption occurs mostly in the ileal part of the small intestine, and in lesser amounts in the duodenum.

Experiments on absorption mostly involve administration of the requisite amounts of different sugars with food and recovery of the unabsorbed sugars from the gut at a desired interval.

Rate of absorption of sugar in rat and pigeon[1] is essentially similar but glucose is absorbed at a rapid rate in chicken than the same in rats.[2] More recent studies[3,4] on glucose absorption, however, reveal that the absorptive capacity of chick with regard to sugars closely resembles that of pigeon[1] and mammal.[5] It is held that the optimal concentration for glucose absorption is somewhere between 0·75 M and 0·2 M[2].

Absorption of glucose from oesophagus, crop or lower oesophagus has never been known to occur. To ascertain the absorptive capability of the different zones of the gut and also to find the relationship, if any, between the feeding habit[6] and rate of absorption, experiments were carried on adult healthy ether-anaesthetised *Passer domesticus* (omnivore), *Streptopelia chinensis* (graminivore), *Bubulcus ibis* (carnivore) and *Corvus splendens* (scavenger) following ligation technique.[7]

The birds were starved for 24 hours to allow emptying of intestinal residues. Thread ligatures were placed at crop-lower oesophageal, lower oesophagus-proventricular, pyloric-duodenal and ileo-caecal junctions in anaethetised birds. Thorough and clean washing is essential for a correct estimation of absorption. Two small incisions were given at the opposite ends of each ligatured section and the part of the gut was washed with Krebs-Ringer biocarbonate solution at 37°.

Ligations 5 to 6 cm apart were given in washed lower oesophagus, duodenum and ileum. One ml Krebs-Ringer bicarbonate solution at 100 mg % glucose concentration at 37° was injected into each of the above segments. The viscera and the ligatured segments were kept moist with Krebs-Ringer bicarbonate solution at 37°.

Absorption was allowed for 30 minutes, following which the segments were separated from the rest of the gut and removed. The post-absorption fluid was collected in vials and the wet weight of the separated segments were recorded. An aliquot of the fluid was taken for colorimetric determination of glucose.[8] Results are expressed in Fig. 1.

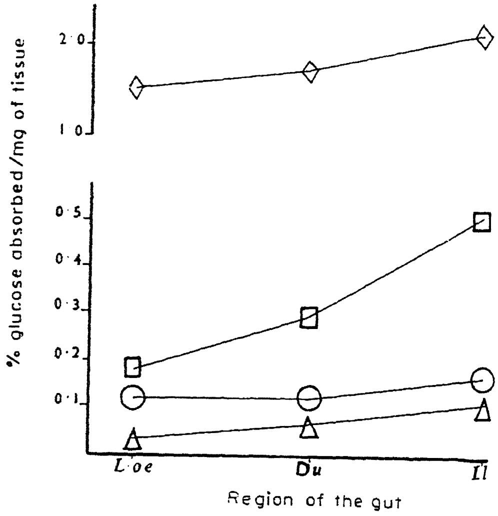


FIG. 1. Absorption of glucose per mg of tissue in 30 minutes by different regions of the gut. expressed in terms of per cent at 37°. One ml gassed (95% O_2, 5% CO_2), warmed (37°), Krebs-Ringer bicarbonate solution at 0·1% glucose concentration is injected in each ligated segment of lower oesophagus (Loe), duodenum (Du) and ileum (Il.) in *Passer domestieus* (◇), *Streptopelia chinensis* (□), *Corvus splendens* (○) and *Bubulcus ibis* (△). Percentage absorption is measured by estimating the unabsorbed glucose and deducting the same from the initial.

An absorption rate of 400 mg/100 gm of body weight/hour had been reported in chick[9] and this rate is more than twice that recorded in rats of similar size and over four times that found in the dog.[10]

The ileum is undoubtedly the chief site of absorption. The rate of absorption of glucose is different in birds belonging to different feeding groups. This indicates that feeding habit has a bearing on the capability of the gut tissue in the absorption of the products of enzymic hydrolysis. The absorption rate is highest per mg of gut tissue in per unit time in an omnivore and this is in a descending order in a graminivore, a scavenger, being lowest in a carnivore. The lower oesophagus has so long been denied of any absorptive function but our observations establish that this part of gut is capable to absorb glucose at a quite high rate. The sparrow is unique in the respect that no amylase is produced in the lower oesophagus, but a considerable amount of glucose is absorbed here. Our findings further suggest that the absorptive capacity is inversely proportional to the size of the animal.

Dept. of Zoology, SHELLEY BHATTACHARYA.
35, Ballygunj Circular K. C. GHOSE.
Road, Calcutta-1, *January* 1, 1971.

---

1. Westenbrink, H. G. K., *Naiure*, 1936, **138**, 203,
2. Henry, K. M., Mac Donald, A. J. and Magee, H. E., *J. Exp. Bicb.*, 1933, **10**, 153.
3. Bogner, P. H., *Proc. Soc. Exp. Biol.*, 1961, **107**, 263.
4. — and Haines, I. A., *Ibid.*, 1961, **107**, 265.
5. Crane, R. K., *Physiol. Rev.*, 1960, **40**, 789.
6. Ali, S., *Book of Indian Birds*, The Bombay Natural History Society, Bombay, 1955.
7. Musacchia, X. J., "Glucose absorption *in vivo*," In *Laboratory Exercises in Comparative Biochemistry and Physiology* (Kerkut, Ed.), Academic Press, New York. 1968.
8. Folin, O. and Wu, H , *J. Biol. Chem.*, 1920, **41**, 367.
9. Golden, W. R. C. and Long, C. N. H., *Am. J. Physiol.*, 1942, **136**, 244.
10. Dukes, H. H., *The Physiology of Domestic Animals*, Comstock Pub. Co., Ithaca, New York, 1947.

A REPORT ON THE EMISSION OF *CERCARIAE PIGMENTATA* FROM *PILA GLOBOSA* (SWAINSON)

THE common South Indian apple snail, *Pila globosa* (Swainson) generally plays no host to larval digenetic trematodes.[1] But very recently Ganapathi and Hanumantha Rao[2] reported cercarial emission from this snail collected at or near Waltair. These cercariae happen to be of echinostomes.

FIGS. 1–2. Amphistome cercariae of *pigmentata* type. Note the eye spots and stellate melanophores, × 75.

In the course of a general survey of freshwater and amphibious gastropod hosts or vectors of Rayalaseema, one specimen of *Pila globosa*, collected from Kodur area, of Rajampet Taluk of Cuddapah District, began to emit pigmented cercariae which could easily be observed with the naked eye. Since the number emitted were few, the specimen was opened and tissues teased and washed in water. Quite a good number of cercariae could be obtained, this way, from the digestive gland. Through microscopic examinations, these have been identified as amphistome cercariae of the *pigmentata* type.[3] The stellate melanophores and the eye spots with spherical lens-like bodies could easily be observed (Figs. 1 and 2). Although the occurrence of adult amphistome in the gut of this snail has previously been reported,[4] there appears to be no previous report of amphistome cercariae from this particular snail. Thus it appears that, besides the usual host *Lymnea luteola* of these parts, *Pila globosa* under certain unknown circumstances can play host not only to echinostome cercariae as reported by Ganapathi and Hanumantha Rao but also to amphistome cercariae.

This research has been financed in part by a grant made by the United States Department of Agriculture under P.L. 480. The authors are thankful to Dr. (Mrs.) P. Padmavathi, College of Veterinary Science, A.P. Agricultural University, Tirupati, for helping in identification of the cercariae.

Dept. of Zoology, D. BALAKRISHNA RAO.
S.V. University, M. C. VENKATA SUBBAIAH.
Tirupati (A.P.), P. VENKATESWARA RAO.
December 30, 1970. K. S. SWAMI.

---

1. Sewell, R. B. S., *Ind. J. Med. Res.*, 1922, **10**, 370.
2. Ganapathi, P. N. and Hanumantha Rao, K., *Curr. Sci.*, 1968, **37**, 19.
3. Dawes, Ben., *The Trematoda*, Cambridge University Press; 1956, p. 424.
4. Anjaneyulu, S. M., *Ind. J. Helminth.*, 1967, **19**, 23.

THE REPRODUCTIVE CYCLE OF THREE DECAPOD CRUSTACEANS FROM THE SOUTH-WEST COAST OF INDIA

THE paucity of information on the reproduction of invertebrates of the west coast of India necessitated detailed investigation on the reproductive cycles of as many representative forms as possible. In crabs, the usual method employed to determine the breeding period had been plotting of the percentage of ovigerous females against time, which provided only an incomplete picture of the sequence of events that take place during the long and often drawn-out breeding season in the tropical waters. Therefore, it was instructive and advantageous to follow the gonad index method. The ratio between the gonad size and body weight bears a relation to gonad development and gonad maturity during different times of the year. This has already been reliably established in fishes,[1] molluscs and echinoderms[2] and crustaceans.[3,4] In the present investigation the reproductive cycles of three species of decapod crustaceans, *viz.*, *Uca annulipes* (Latreille), *Portunus pelagicus* (Linnaeus) and *Metapenaeus affinis* (Milne-Edwards), have been studied employing the gonad index method.

Fortnightly samples consisting of ten males and ten females of *Uca annulipes* were collected from the shores of Cochin Backwaters. Samples of *Portunus pelagicus* and *Metapenaeus affinis* were obtained from the trawlers operating off Cochin on the shelf region. The specimens were rendered free of moisture first by towelling and later with filter-paper. The individual weights were then determined. The gonads were carefully dissected out and weighed. The wet weight of the gonad was then divided by the wet weight of the body and this factor was multiplied by a hundred and the value was taken to represent the gonad index. The mean gonad index values for males as well as for females in each month for a period of three years from October 1963 were calculated and presented in the figure.

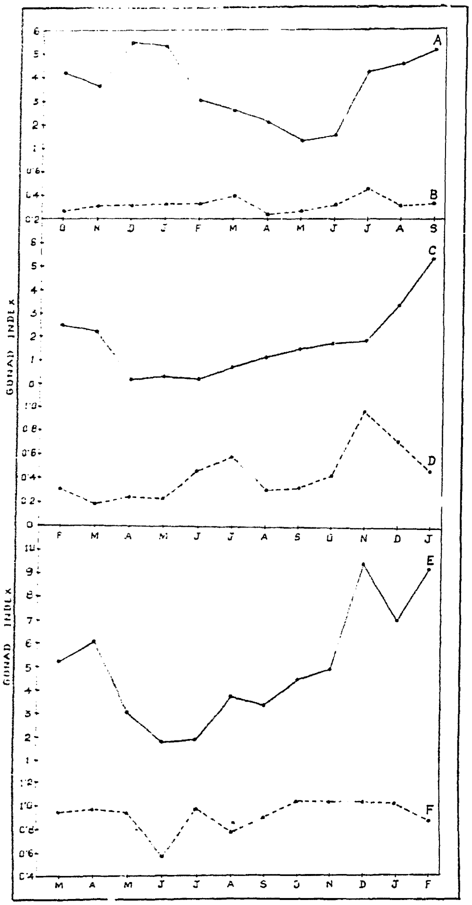


FIG. 1. The reproductive cycle of *Uca annulipes*, *Portunus pelagicus* and *Metapenaeus affinis*. A. Female *U. annulipes*; B. Male *U annulipes*; C. Female *P. pelagicus*; D. Male *P. pelagicus*; E, Female *M. affinis*; F. Male *M. affinis*,

From Fig. 1, it will be seen that in the female *U. annulipes* the gonad index remains high during the months from July to February with a peak in December. *P. pelagicus* has a high gonad index for several months of the year from August to March with a definite peak during December-January. In this connection it may be noted that from the east coast of India, Rahaman[4] reported that this species is a continuous breeder with three periods of maximal gonad indices, November, January and June with greater activity during November-January. In *M. affinis* high gonad index prevails from August to April with a major peak during December-February and a minor peak in April. The male and female reproductive cycles of these crustaceans are not concurrent. The peak of the reproductive cycle of males occurs slightly earlier in the breeding season than that of the females. In *U. annulipes* and M. *affinis*, the fluctuation of the gonad index of testis is not so conspicuous as that of the ovary. In males of all these three species, sperms and spermatophores have been noticed throughout the year. In all these species, the possibility of production of successive broods of eggs by an individual in a breeding season is indicated from the nature of the gonadal cycle.

In all these three crustaceans, the breeding season is not continuous all the year round but extends over several months of the year with distinct peak periods of gonadal activity. It may be noticed that the low saline conditions prevailing during the period of the south-west monsoon are apparently unsuitable for breeding. The medium and high saline conditions of the ambient water during the post-monsoon and pre-monsoon periods respectively, with abundant planktonic food[5,6] for the larvae of these crustaceans, seem to be most favourable for breeding activity.

Mahatma Gandhi College, K. KRISHNA PILLAY.
Trivandrum-4 ; and
Dept. of Marine N. BALAKRISHNAN NAIR.
Biology,
University of Kerala,
Trivandrum-7, December 14, 1970.

---

1. Qasim, S. Z., *Proc. zool. Soc. Lond.*, 1957, **128**, 161.
2. Giese, A. C., *Ann Rev. Physiol.*, 1959, **21**, 547.
3. Subramanyam, C. B., *Curr. Sci.*, 1963, **32**, 165.
4. Rahaman, A. A., *Proc. Indian Acad. Sci.*, 1967, **65 B**, **76**.
5. Banse, K., *J. mar. biol. Ass. India*, 1959, **1**, 33.
6. Panikkar, N. K. and Jayaraman, R., *Proc. Indian Acad. Sci.*, 1966, **64 B**, 231.

CYTOGENETICAL INVESTIGATIONS FOLLOWING CENTRIFUGATION OF GERMINATING WHEAT SEEDS

THE occurrence of contradictory reports regarding the mutagenic effects of centrifugation in plants[1-4] and animals[5,6] prompted an investigation to assess the effects of centrifugal force on the germinating seeds of hexaploid wheat, *Triticum aestivum* L. (Variety C. 591). Wheat was particularly chosen because of its tolerance to chromosomal aberrations including losses or additions of single or pairs of chromosomes.

Seeds pre-soaked in water for 24 hours, were subjected to centrifugal forces at 6,000, 9,000, 12,000 and 18,000 r.p.m., continuously, for 3 hours, at 0° C internal temperature, using a "PR-2" model of the centrifuge of the International Equipment Company, U.S.A. One set of centrifuged germinating seeds, spread over a filter-paper in petri dishes, for 12 hours' duration, for a recovery from the shock, was used for cytological observations by fixing the roots in acetic alcohol (1 : 3), whereas the other lot was transplanted into the field. Standard technique of acetocarmine smears was followed for both the mitotic and meiotic studies.

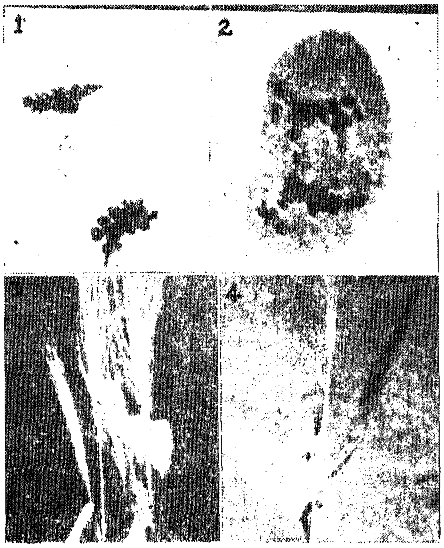
An approximate inverse relationship exists between the centrifugal force applied from 6,000 to 18,000 r.p.m. and the reduction in the percentage of seed germination from 96·5% to 89·0%, respectively. Root tip smears revealed elongated nuclei and also cells with nuclei occupying excentric positions. The reduction in seed germination may be attributed to the adverse effects of the centrifugation like amitosis, elongation of nuclei, etc., in the actively dividing cells at the time of treatment. The results are summarised in Table I.

TABLE I

Cytogenetic effects of centrifugal force

Dose	Mitotic index (%)	Pollen sterility (%)	Cells with chromosomal aberrations (%)	Frequency of chimeric plants (%)		
				Chlorophyll sectors	Lax earheads	Subcompactoid spikes.
Control ..	8·3	3·0	0	0	0	0
6,000 r.p.m. ..	..	..	..	..	..	..
9,000 r.p m. ..	7·2	4·0	0	0	0	0
12,000 r.p m. ..	5·9	10·0	4·0	0	0	0
18,000 r.p.m ..	4·6	15·0	12·0	1·0	3·0	0·5

The mitotic index was computed to evaluate the effects of centrifugal force on the rate of root tip mitosis. A linear decrease in the mitotic index with increase in the dose was found. In addition, at higher doses there were proportionately larger number of cells in metaphase than at other stages as compared to the non-centrifugal controls. This might be due to the injury caused to the spindle and hence resulting in the accumulation of cells at metaphases. The pollen mother cell meiosis was studied to observe the effects of centrifugal force on the chromosomes. The frequency of cells with aberrant chromosomes, *viz.*, laggards (Fig. 1), anaphase bridges (Fig. 2) and micronuclei, increased from 4% at 12,000 r.p.m. to 12% at 18,000 r.p.m. Similarly, the amount of pollen sterility, as determined by their stainability in acetocarmine, showed a linear increase at higher doses of centrifugation.



FIGS. 1-4. Fig. 1. Telophase showing lagging chromosomes. Fig. 2. Two anaphase bridges. Fig. 3. Chimeric plant with lax earhead to the left and the normal ones. Fig. 4. Monoculmed plant.

In the first generation after treatment, a few chimeric plants with chlorophyll variegations (striata, albina), lax earheads (Fig. 3) and subcompactoid spikes were observed at the highest dose. This could be explained by assuming that centrifugation induced genetic changes in the primordial cells of the germinating seeds which gave rise to these morphological aberrants. At 18,000 r.p.m., a few monoculmed plants (Fig. 4) were also observed. Further, there was considerable reduction in the mean earhead number per plant and increase in the number of mean days to maturity with the increase in the dose of centrifugation. This may be presumed to be due to the induction of mutations in genes influencing these quantitative traits.

In the light of the above findings, it may be concluded that the creation of a "pseudogravity" by way of centrifugation can not only interfere with the dynamics of cell division, but can also induce cytogenetical changes in higher plants.

One of us (T. P. R.) is grateful to Dr. M. S. Swaminathan, Director, I.A.R.I., New Delhi, for providing all the facilities during these investigations.

Dept. of Genetics, T. P. Reddy.
Osmania University,
Hyderabad-7 (A.P.), and
Division of Genetics, D. Srinivasachar.
I.A.R.I., New Delhi-12, *December* 8, 1970.

---

1. Stubbe, H., *Z. indukt. Abstamm. u Vererbungslehre*, 1930, **56,** 202.
2. Kostoff, D., *Cytologia*, 1938, **8,** 420.
3. Yu, C. K. and Dodson, E. O, *Genetics*, 1961, **46,** 1411.
4. Sax, K., *Proc. Nat. Acad. Sci., U.S*, 1943, **29,** 18.
5. Frank, W. E. and Dodson, E. O., *Canad. J. Genet. Cytology*, 1961, **3,** 295.
6. Reddy, O. S, *Nature*, 1963, **198,** 316.

ACTION OF SOME ANTHOCYANIN PIGMENT CONTROLLING GENES IN *ZEA MAYS*

The mechanism of gene action and interaction in the control of biochemical pathways have been studied extensively in micro-organisms compared to higher organisms, including maize. Recent developments have proved beyond doubt that genes control biological reactions through the mediation of enzymes and that mutation affects or alters such reactions which may ultimately change the phenotype.

In maize, the production of anthocyanin pigment in the aleurone tissue, the outermost layer of the endosperm is under the control of a large number of complementary genes, their alleles and several modifiers.[1] The genes A_1, A_2, C_1, C_2 and R must be present in dominant condition at least in one dose for the formation of anthocyanin pigment. The gene C^I inhibits the synthesis of anthocyanin. Modifier genes like *in*, *bz1*, *bz2* r^h indirectly alter the intensity of the pigment in aleurone and other plant parts. Hence, the genetic system of anthocyanin biosynthesis in maize offers a unique advantage to study the biochemical basis of gene action.[1] Recent studies have established the gene action sequence for anthocyanin synthesis.[2] However, a thorough study of intermediates and various gene controlled different anthocyanins is necessary. The present study deals with the role of *Pr*, r^{ch}, and *B* genotypes in the control of anthocyanin production in maize.

The different genetic stocks, homozygous for *B*, r^{ch} and *Pr* were used for the qualitative identification of the pigment. The dried husk is cut into pieces and extracted with 1% hydrochloric acid in ethanol. Similarly, the extraction of pigment from the seeds is done by soaking them in 1% hydrochloric acid in ethanol after peeling off the pericarp. The extract is condensed to a small volume to increase the concentration. It was then purified by chromatography on Whatman No. 1 filter-paper using the BAW solvent system (6 butanol : 1 acetic acid : 2 water). Purified pigment along with pure samples are co-chromatographed and R_f values are enumerated. The pigments are eluted from chromatograms with 1% HCl in ethanol and the spectrophotometric studies are made on Beckman model DB spectrophotometer. The absorption maxima and R_f values of each genotype along with those of pure samples are given in Table I.

The absorption maxima and R_f values consistently suggest that the pigment accumulated in *B*, r^{ch} and *Pr* is cyanidin-3 monoglucoside. However, the earlier studies with *Pr* genotype also revealed that it accumulates cyanidin-3 monoglucoside.[3,4] The present work not only confirms independently that the nature of the pigment in *Pr* genotype as cyanidin-3 monoglucoside,[5] but further extends that the accumulated pigment in *B* and r^{ch} genotypes is also cyanidin-3 monoglucoside as is evident by the absorption maxima and R_f values (Table I).

Table I

Comparison of the R_f values and absorption maxima of anthocyanins obtained from mutants (Pr, r^{ch}, B) and pure sample

Pigment source		Average R_f values in ($R_f \times 100$) BWA	Absorption maxima in mμ (λ_{max}, mμ)
B (husk)	..	23	531
r^{ch} (husk)	..	23	528
r^{ch} (seed)	..	23	530
Pr (seed)	..	23	535
Pure cyanidin chloride	..	55	546
Pure pelargonidin chloride	..	79	525
Pure cyanidin 3-monoglucoside		21	534

The fact that all the three genotypes (*B*, *Pr*, r^{ch}) accumulate an identical compound, suggests that these genes might play an indirect role in the quantitative control in the biosynthesis of anthocyanin. It is evident from visual comparison of genotypes that *r* in recessive condition produces more pigment than *Pr* or *B*. These genes may regulate the availability of the precursor(s) in anthocyanin biosynthesis.

Dept. of Genetics, K. Vaidyanath.
Osmania University, G. M. Reddy.
Hyderabad-7, *December* 30, 1970.

---

1. Rhoades, M. M., *Amer. Nat.*, 1952, **86**, 105.
2. Reddy, G. M. and Coe, E. H., *Science*, 1962, **145**, 3537.
3. Coe, E. H., *Genetics*, 1955, **40**, 568.
4. Harborne, J. B. and Gevazzi, G., *Phytochemistry*, 1969, **8**, 999.
5. Vidyanath, K. and Reddy, G. M., *Maize Genetics, Coop. News Letter*, 1969, **43**, 136.

SOLUBILIZATION OF TRICALCIUM PHOSPHATE BY BLUE-GREEN ALGAE

Microbiological solubilization of bound phosphates is one of the important biological processes in soil. Several soil bacteria[5,6,8,9,12,13,15,16] and fungi[1,2,4,6,10,14] have been shown to possess the property of solubilizing tricalcium phosphate in culture. Although the role of blue-green algae as a biological input in agriculture has been well documented,[11,17,20,22] these organisms do not seem to have been examined for their capacity to solubilize bound phosphates. The present investigation is an attempt in this direction.

Twenty-seven strains of nitrogen-fixing blue-green algae belonging to four genera and one non-nitrogen-fixing *Anacystis nidulans* were screened for their ability to solubilize tricalcium phosphate in culture media. All the strains were from the Culture Collection of Microalgae in the Division of Microbiology. 100 ml flasks containing 50 ml of nutrient medium (0·2 g $MgSO_4.7H_2O$, 0·1 g $CaCl_2$, 0·25 g KNO_3, 1 ml A_5 micronutrient solution and 1 ml Fe-EDTA per litre) and 50 mg tricalcium phosphate were sterilized at 15 lb for 30 min and inoculated with 3 ml of a uniform algal suspension from 20-day-old cultures. Uninoculated flasks served as controls. After 15 days' incubation under identical conditions of temperature (28 ± 1° C) and illumination (*ca* 5,000 lux), the contents of the flasks were filtered through a Whatman No. 1 filter-paper and the filtrates, after making up to a constant volume (50 ml) were analysed for pH using a glass electrode Beckmann Zeromatic II pH meter and for the amount of phosphorus[7] in excess of that released by mere autoclaving of the medium. The latter indicated the extent to which the algal strains solubilized insoluble phosphate in the medium.

Table I summarizes the results. Among the 28 strains screened, 17 were found to be effective in this regard. They belonged to the genera *Anabaena*, *Nostoc*, *Tolypothrix* and *Aulosira*. Although the property to solubilize insoluble phosphate seems to be well distributed in this group of organisms, the quantum of solubilization is, however, lower than by bacteria. Particular interest centres round *Tolypothrix tenuis* and *Aulosira fertilissima*, the two most widely used forms in inoculation trials.[11,17,20,22] Both these forms were able to solubilize tricalcium phosphate (1·55 and 1·07 mg P_2O_5/50 ml). Equally efficient were five strains of *Nostoc* (205, 203, 278, 282 and 270).

It was not possible to equate the pH of the culture filtrates with phosphate solubilization and this is in conformity with the observations on other phosphate-solubilizing micro-organisms.[3,12,13]

Table I

Solubilization of tricalcium phosphate by strains of blue-green algae
(Average of triplicates)

Algae	No tested No. significant in solubilization	Serial No. of strains showing significance	mg P_2O_5/ 50 ml	pH of the culture filtrate
Control (uninoculated)	..	..	0·76	6·6
Anabaena	9/5	290	0·88	7·6
		287	0·88	6·8
		299	0·94	6·9
		311	0·88	7·4
		310	0·88	6·9
Nostoc	16/10	205	2·19	7·3
		203	2·27	7·3
		261	0·85	7·3
		231	0·88	6·8
		278	1·01	6·9
		282	1·01	7·3
		270	1·39	7·0
		211	0·94	7·3
		234	0·88	6·9
		238	0·88	7·0
Tolypothrix tenuis	1/1	173	1·55	7·7
Aulosira fertilissima	1/1	68	1·07	7·6
Anacystis nidulans	1/0	..	..	..

C.D. 5% 0·06.

The present observations show that besides possessing capacities to fix nitrogen,[18] to produce growth substances[19] and to tolerate high levels of agricultural chemicals,[21] some of these nitrogen-fixing blue-green algae are also able to solubilize bound phosphates.

We are thankful to Dr. W. V. B. Sundara Rao, Head of the Division of Microbiology, for his interest in the study.

Division of Microbiol.., I.A.R.I., New Delhi-12, *December* 16, 1970.
Paromita Bose.
Ujjal Singh Nagpal.
G. S. Venkataraman.
S. K. Goyal.

---

1. Abbott, E. V., *Soil Sci.*, 1923, **16**, 207.
2. Chhonkar, P. K. and Subba Rao, N. S., *Can. J. Microbiol.*, 1967, **13**, 749.
3. Das, A. C., *J. Indian Soc. Soil Sci.*, 1963, **11**, 203.
4. Gerretsen, F. C., *Plant & Soil*, 1948, **1**, 51.
5. Goswami, K. P. and Sen, A., *Indian J. agri. Sci.*, 1962, **32**, 96.
6. Katznelson, H., Peterson, E. A. and Rouatt, J. W., *Can. J. Bot.*, 1962, **40**, 1181.
7. Koenig, R. A. and Johnson, C. R., *J. Ind. Eng. Chem.*, 1942, **14**, 155.
8. Menkina, R. A., *Mikrobiologiya*, 1950, **19**, 308.
9. Sen, A. and Paul, N. B., *Curr. Sci.*, 1957, **26**, 222.
10. Sethi, R. P. and Subba Rao, N. S., *J. gen. appl. Microbiol.*, 1969, **14**, 329.
11. Singh, R. N., *Role of Blue-Green Algaein the Nitrogen Economy of Indian Agriculture*, I.C.A.R., New Delhi, 1961, p. 175.
12. Sperber, J. I., *Aust. J. agri. Res.*, 1958, **9**, 778, 782.
13. —, *Nature*, 1957, **180**, 994.
14. Subba Rao, N. S. and Bajpai, P. D., *Experentia*, 1965, **26**, 386.
15. Sundara Rao, W. V. B. and Sinha, M. K., *Indian J. agri. Sci*, 1963, **33**, 272.
16. Swaby, R. J. and Sperber, J. I., *Soil & Fert.*, 1959, **22**, 286.
17. Venkataraman, G. S., *Phykos*, 1966, **5**, 164.
18. —, *The Cultivation of Algae*, I.C.A.R., New Delhi, 1969, p. 310.
19. — and Neelakantan, S., *J. gen. appl. Microbiol.*, 1967, **13**, 53.
20. — and Goyal, S. K., *Mikrobiologiya*, 1969, **38**, 709.
21. — and Rajyalakshmi, B., *Indian J. agri. Sci.*, 1970 (under publication).
22. Watanabe, A., *J. gen. appl. Microbiol.*, 1962, **8**, 85.

PHYTOTOXIC BEHAVIOUR OF METABOLIC BY-PRODUCT OF *NIGROSPORA ORYZAE* (BERK. AND BR.) PETCH ON SOME VARIETIES OF *ORYZA SATIVA*

In the light of previous work[1-10] on toxin production as metabolic by-products in the culture filtrates of pathogenic fungi, the present investigation has been undertaken to determine phytotoxic behaviour of the metabolic by-products of *Nigrospora oryzae* (Berk. and Br.) Petch on different varieties of *Oryza sativa* commonly grown in India.

The test-fungus, *N. oryzae*, was isolated from diseased leaves of *Oryza sativa* collected from rice fields near Burdwan, West Bengal, in November 1969. Monosporous culture of the fungus was made on malt-agar and was kept as stock culture. For preparation of culture filtrate, the fungus was grown on liquid Czapeks medium. The medium was then adjusted to pH 6·5 and 25 ml of it was transferred to each 250 ml Erlenmeyer flask and sterilized for 15 minutes at 15 lb pressure. The flasks were inoculated with uniform disc (5 mm diam.) of mycelium punched out from actively-growing culture of the test-fungus on Czapeks' agar medium in petri dishes. Inoculated flasks were then incubated at 30° C for 21 days. Mycelium was then separated by filtration and the filtrate was adjusted to pH 6·5 and sterilized to kill any remaining mycelial fragments. The sterile culture filtrate was used in making dilutions for the seedling assay of toxicity.

Seeds of some important varieties of rice, NC 1626, Satika, Jhingasal, Basmati, Kumangore and NC 1281 were allowed to soak for 30 min in distilled water and then removed to a moist chamber to germinate for 24 hours. Five seedlings with roots and shoots of uniform size (about 5 mm) were placed on filter-paper within sterile petri dishes soaked with 5 ml of culture filtrates of 1 : 10 and 1 : 100 dilutions in distilled water following Luke and Wheeler.[11] Adequate controls in distilled water was kept. The petri dishes were incubated at 30° C for 48 hours to allow the seedlings to grow. The length of the roots and shoots were then measured and recorded (Table I).

Table I

Effect of culture filtrate of Nigrospora oryzae *on seedlings of different varieties of* Oryza sativa *after 48 hours*

Variety	Increase in length of root* (in mm)			Increase in length of shoot* (in mm)		
	1:10	1:100	Control	1:10	1:100	Control
NC 1626 ..	40	48	60	19	20	20
Satika ..	50	56	58	20	23	25
Jhingasal	50	59	63	17	18	20
Basmati ..	37	45	58	16	20	24
Kumargore	46	57	73	17	22	30
NC 1281	47	51	58	20	21	25

* Average of five replicates.

There is considerable inhibition of growth in roots and shoots when treated with metabolic solution in comparison to the control. Moreover, in 1 : 10 dilution, greater inhibition occurs than in 1 : 100. Of the varieties tested, maximum root inhibition has been observed in Kumargore which is followed in descending order by Basmati, NC 1626, Jhingasal, NC 1281, the minimum being in Satika. Regarding shoot growth, there is response of toxin inhibition but not to the same extent as the root response.

Dept. of Botany, SANDHYA SANTRA.
University of Burdwan, BALEN NANDI.
West Bengal, *December* 2, 1970.

---

1. Meehan, F. and Murphy, H. C., *Science*, 1947, **106**, **270**.
2. Letzenberger, S. C., *Phytopath.*, 1949, **39**, 300
3. Pringle, R. B., and Braun, A. C., *Ibid.*, 1957, **47**, 369.
4. Wheeler, H. E. and Luke, H. H., *Ibid.*, 1954, **44**, 334.
5. Aksenova, V. A., *Doklady*, 1963, **147**, 1426.
6. Porter, C. L. and Green, R. J., *Phytopath.*, 1952, **42**, 472.
7. Ludwig, R. A., *Plant Pathology*, by Horfall, J. G. and Diamond, A. E., 1960, **2**, 315.
8. Deverall, B. J., *Symposium for General Microbiol.*, 1964, **14**, **165**.
9. Purkayastha, R. P., *Proc. Nat. Inst. Sci. India*, 1969, **35**, 385.
10. Scheffer, R. P. and Pringle, R. B., *Nature*, 1961, **191**, 912.
11. Luke, H. H. and Wheeler, H. E., *Phytopath.*, 1955, **45**, 453.

OCCURRENCE OF *HIBISCOXYLON INTERTRAPPEUM* SP. NOV. FROM THE DECCAN INTERTRAPPEAN SERIES OF MAHURZARI, NEAR NAGPUR (M P.), INDIA

A FOSSIL axis, 6 cm × 5 cm, was collected from Mahurzari, near Nagpur (Maharashtra State) by one of us (K. A.), in December 1969. The wood is of diffused porous type and does not show growth rings. The bark and peripheral portion of the wood are well preserved but the central portion is missing (Fig. 1 and Photo 1).

The vessels can be seen even with the naked eye (Photo 1). In the middle portion of the wood they are solitary but occur closely packed in peripheral region; they also occur in two to four in radial rows. The vessels are small to medium and vary from 165 μ to 300 μ in length and 49 μ to 198 μ in width. Vessel perforations are simple and somewhat oblique (Metcalfe and Chalk),[5] the vascular pits are alternate to subopposite.

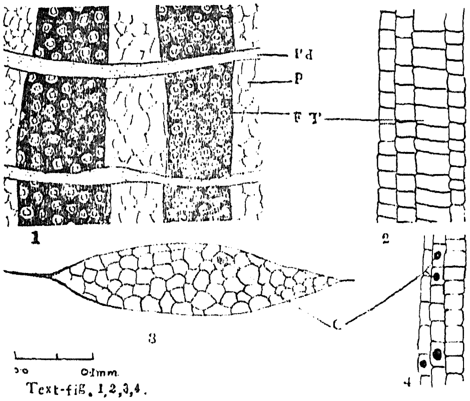
Wood parenchyma is paratracheal, confluent and occurs associated with the vessels (Photo 1). Xylem rays are closely packed, heterogeneous and may be uniseriate. The rays in longitudinal plane are fusiform in shape. Uniseriate rays consist wholly of upright cells (Webber[6,7]). Height of xylem rays varies from 1-25 cells.

Tile cells of *Pterospermum* type, mostly in a single row, are present (Chattaway[1-3]); rarely they may be present in two rows (Figs. 2, 3 and 4).

The ground mass of the wood consists of fibrous cells. Fibres are tapering and well preserved, they are angular with walls about 16 μ thick. They are libriform and measure upto 1 mm in length. The peripheral zone of bark consists of fibrous bands alternating with parenchymatous bands (Fig. 1 and Photo 1).

PHOTO. 1. A photograph of fossil wood in transverse plane showing bark and wood portion, × 5.

Probably crystals of calcium oxalate are present in the parenchymatous cells of the xylem rays as well as other parenchyma cells (Figs. 3 and 4).



FIGS. 1–4 Fig. 1. T.S. of bark of fossil wood showing fibrous bands alternating with parenchymatous bands. Fig. 2. Single xylem ray in R.L.S. plane showing tile cells of *Pterospermum* type. Fig. 3. Xylem ray in T.L.S. plane Fig. 4. Xylem ray in R.L.S. plane showing crystals. (*Pd*, Periderm; *P*, Parenchyma; *F*, Fibres; *T*, Tile cells; *C*, Crystals.)

The structure and size of the vessels, the presence of ailiform to confluent parenchyma in the wood, the structure of xylem rays and the presence of fibres in the bark are the characters which are found in the fossil as well as in the extant genus *Hibiscus*. The presence of *Pterospermum* type of tile cells in the fossil goes further to pinpoint the affinities with the living genus.

We believe that the fossil genus is very close thosporium oryzae *to Fytolan and Dithane* sembles the fossil wood in all details. We, therefore, prefer to name it as *Hibiscoxylon intertrappeum* sp. nov. Genus *Hibiscoxylon* is reported for the first time from India. The only other fossil record of this genus is from the Cretaceous of Egypt (R. Kräusel, 1939).[4]

Dept. of Botany, B. S. TRIVEDI.
Lucknow University, K. AMBWANI.
Lucknow, *November* 7, 1970.

---

1. Chattaway, M. M., "The wood of Sterculiaceae. I. Specialization of the vertical wood parenchyma within the subfamily Sterculae," *New Phytol.*, 1932, **31** (3), 119.
2. —, "Ray development in Sterculiaceae," *Forestry*, 1933, **1** (2), 93.
3. —, "Tile cells in the rays of the Malvales," *New Phytol.*, 1933, **32**, 261.
4. Kräusel, R., "Ergebnisse der Forschungsreisen Prof. E. Stromers in den wusten Agyptens IV. Die Fossilen Floren Agypten," *Abh. Bayer. Akad. Wiss. Abt. Math. Naturw N.F.*, **47**, 1.
5. Metcalfe, C. R. and Chalk, L., *Anatomy of Dicotyledons*, 1955, **1** & **2**.
6. Webber, I. E., "Bearing of upright ray cells in the wood of *Hibiscus mutabilis* on usage of the term tile cells," *Trop. Wood.*, 1934, **37**, 14.
7. —, "Systematic anatomy of the Malvales," *Ibid.*, 1934 (35), 15.

INDUCED TOLERANCE OF SPORES OF *HELMINTHOSPORIUM ORYZAE* BREDA DE HAAN TO FUNGICIDES

INCREASED tolerance of fungi to fungicides *in vitro* as a result of successive transfers of the fungi from media containing lower to higher concentrations of the fungicides have been reported by several workers.[1-4] In West Bengal, brown spot of rice caused by *Helminthosporium oryzae* Breda de Haan is the most serious disease of the crop and the control measures against the disease include prophylactic spraying with fungicides. As the spores of the fungus serve as the chief agent for the spread of the disease experiments were undertaken in this laboratory to study the increased tolerance of the spores of *H. oryzae* to Fytolan (copper oxychloride) and Dithane M-45 (manganese ethylene bisdithiocarbamate) and the pathogenicity of the tolerant spores in inducing leaf spot symptoms in rice seedlings previously sprayed with these fungicides. The findings of these experiments are presented in this note.

(*a*) *Induced Tolerance of Spores of* Helminthosporium oryzae *to Fytolan and Dithane M-45.*—0·02 ml of water suspensions of both the fungicides at 500 ppm strength were placed in cavity slides and dried. 0·02 ml of spore suspensions in sterile distilled water were then placed in these cavity slides, the slides were kept in moist chambers prepared by placing water-soaked filter-papers on both sides of petri dishes and incubated for 24 hours at 27° C for spore germination. Control was kept without fungicides. After recording the germination percentage, the spore suspensions in the cavity slides were picked up by sterilized micropipettes, the spores washed in sterile distilled water by centrifuging and the washed spores were seeded on potato dextrose agar plates and incubated at 27° C for four days for allowing the surviving spores to grow and sporulate again. This was regarded as the second generation. From this culture also spore suspensions were allowed to germinate on fungicides in the similar way and the process was repeated upto the eighth generation.

It was noted that due to repeated transfers of the spores of *H. oryzae* to fungicidal suspensions, the tolerance of the spores to the fungicides gradually increased as was indicated by increased spore germination. In case of Fytolan, it increased from 11% in the first generation to 48% in the eighth generation while in case of Dithane M-45, the increase was from 10% to 42%. In the control, the percentage of spore germination was 83.

(*b*) *Pathogenic Ability of the Fungicide-Tolerant Spores of* H. oryzae *to Cause Leaf Infections in Rice Seedlings Previously Sprayed with Fungicides.*—15-day-old rice seedlings were sprayed with 0·2% aqueous suspensions of Fytolan and Dithane M-45 respectively. After 24 hours, the seedlings were spray-inoculated with spore suspensions prepared from the tolerant spores of the eighth generation multiplied on PDA. In the control seedlings were inoculated with spores of non-tolerant original culture. The results are presented in Table I which shows that when inoculated on fungicide-sprayed rice seedlings, the respective tolerant spores of *H. oryzae* were able to induce much greater leaf infection in the seedlings as compared to the non-tolerant spores.

TABLE I

Leaf infection in fungicide-sprayed rice seedlings caused by inoculation with fungicide-tolerant spores of H. oryzae

Treatments	Seedlings sprayed with Fytolan		Seedlings sprayed with Dithane M-45	
	Inoculated with Fytolan tolerant spores	Inoculated with non-tolerant spores	Inoculated with Dithane M-45 tolerant spores	Inoculated with non-tolerant spores
Leaf infection value	3·2	0·2	2·8	0·3

The present studies indicate the great significance of fungicidal tolerance by pathogenic fungi in plant pathology, particularly in respect to the control of plant pathogens by fungicides.

The authors express their thanks to Dr. S. B. Chattopadhyay, Professor of Plant Pathology, for his interest.

Dept. of Plant Pathology, P. K. SEN GUPTA.
Faculty of Agriculture, S. N. DAS.
University of Kalyani,
P.O. Mohanpur (Dist. Nadia),
West Bengal, *December* 23, 1970.

---

1. Parry, K. E. and Wood R. K. S., *Ann. appl. Biol.*, 1958, **46**, 446
2. Grover, R. K. and Moore, J. D., *Phytopathology*, 1961, **51**, 399.
3. Partridge, A. D. and Rich, A. E., *Ibid.*, 1962, **52**, 1000.
4. Reddy, D. V. R. and Apparao, A., *Indian Phytopathology*, 1964, **17**, 35.

AN UNDESCRIBED SPECIES OF *PYRENOCHAETA* ON AN ECONOMIC HOST

DURING the routine mycological collections in and around Poona, the writers collected an interesting but a rare pycnidial fungus on *Crotalaria juncea* L. (sunnhemp), causing typical shallow, oval to irregular, pale-brown bleached spots on the stems. Sections through such infected lesions revealed the presence of abundant, dark setose pycnidial bodies of a fungus, which was later identified as a species of the form-genus *Pyrenochaeta* de Not. A thorough search and perusal of literature revealed no report of any species of *Pyrenochaeta* on this host or its allied species. The present species also differed considerably in gross morphological characters, dimensions of pycnidia, pycnidiospores and setae from other species of *Pyrenochaeta* reported on other leguminous hosts, as well as the type species, *viz.*, *Pyrenochaeta nobilis* de Not.[1] Hence, the present fungus is described as a new species with the following Latin diagnosis :

Pyrenochaeta crotalariae SP. NOV.

Infectionis maculae, sordide brunneae vel fusce-brunnea, irregulariter, rotundae vel ovales, dispersae. Pycnidia fusce-brunnea, ostiolatae (24·0 to 53·2 μ in diam.), sphaerica vel globularia, superficialia, ornata uno, raro pluribus, setosa cd ore, 91·2–256·0 μ in diam. Setae fusce-brunneae, obtusae, rigidae, erectae, numeris, circumscriptae circum ostiolum vulgo septatae, 60·8–210 μ × 3–7 μ. Pycnidiosporae unicellulatae, hyalinae, sed fuscae in massa, ovatae, 3–8 μ × 2–3 μ.

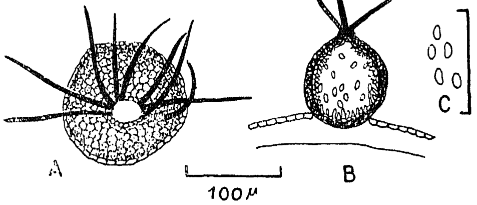


FIG. 1. A, Pycnidium with setae ; B, Pycnidium in section ; C, Pycnidiospores.

In culmis viventibus, *Crotalaria juncea* L. (sunnhemp), Leg. R.T.S. (5-8-1970) ad Poona, M.A.C.S. Herbarium Sub. Numero (882) (Typus).

Grateful thanks are due to Prof. M. N. Kamat for his keen interest and helpful suggestions, and to the Director for the facilities.

M.A.C.S. Res. Inst., V. G. RAO.
Poona-4 (India), R. T. SOLANKURE.
December 19, 1970.

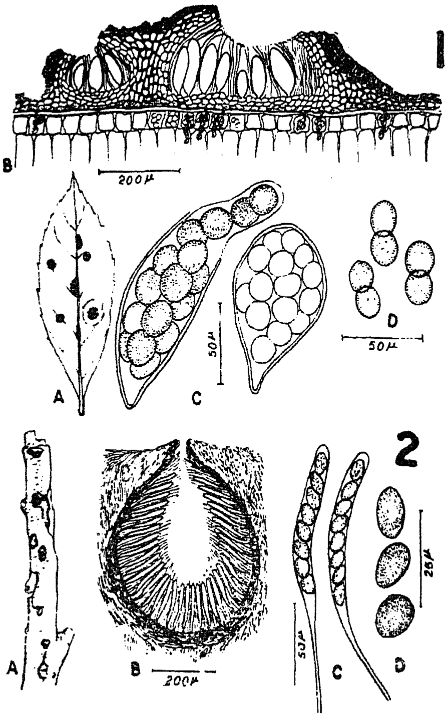
---

1. Saccardo, P. A., *Sylloge Fungorum*, 1884, **3**, 219.

COCCONIA PLACENTA AND *PENZIGIA PLACENTA*—TWO NEW RECORDS OF ASCOMYCETES FROM INDIA

DURING his routine mycological collection from Coorg forests of Mysore State, the writer collected (1) a tar spot fungus infecting living leaves of *Symplocus spicata* Roxb. (Symplocaceae), and (2) a lignicolous xylariaceous member inhabiting the dry twigs of *Artocarpus integrifolia* L. (Moraceae) during the month of May 1969.

The stromatic tar spot fungus was amphigenous, circular in outline with irregular surface reaching a diameter upto 6 mm with unusual pattern of radiating lines over the scutellum in the form of black superficial circular discs attached to the leaf tissue by a central pseudoparenchymatous stromatic placenta. Transverse sections of the same revealed the stroma fixed into the leaf tissue with the help of a few stromal placenta-like structures with the rest of the stroma remaining free over the host lamina. The stromatic discs revealed the presence of radially linear locules filled with pseudoparaphyses and bitunicate 8-spored asci and 2-celled equally septate ascospores on the basis of which the fungus was identified as *Cocconia placenta* (Berk. and Br.) Sacc. (family: Parmulariaceae). This fungus was originally collected on this host from Ceylon but was not represented among Indian fungi. Thus a brief description is given.



FIGS. 1-2. Fig. 1. *Cocconia placenta* (Berk. and Br.) Sacc. Fig. 2. *Penzigia placenta* Petch. (A, Habit; B, Section through the ascocarp; C, Asci; D. Ascospores.

Cocconia placenta (Berk. and Br.) Sacc. (Fig. 1) *Syll. Fung.*, 8: 738 (1889)

Infection spots circular, dark, amphigenous, scutellum radiate, ascostroma attached at the centre and sometimes radially at the other places, 1-6 mm in diameter and 250-300 μ in thickness.

Locules linear and radiate, 800-1,000 μ × 300-400 μ. Asci club-shaped, bitunicate, parallel in basal layers, pseudoparaphyses present, 80-85 μ × 30-35 μ. Ascospores 8, roughly distichous, dark-brown, 2-celled, equally septate, deeply constricted at septum, both the cells are round to slightly oval and often get separated, 30-38 μ × 15-17 μ.

On living leaves of *Symplocus spicata* Roxb. collected at Mercara, Coorg, Mysore State, 15th May 1969. B. A. Ullasa, M.A.C.S. Herb, No. 1175.

The other xylarioid fungus having white internal stromal tissue characteristic of *Xylaria* but featuring stromata of hypoxylarioid form with a central stipe was identified as *Penzigia placenta* Petch (Family: Xylariaceae). Miller[1] considered *Penzigia* in the above sense as intermediate between *Xylaria* and *Hypoxylon*. Martin[2-4] does not recognise the genus and distributed species of *Penzigia* among the two genera, *viz.*, *Xylaria* and *Hypoxylon*. This genus is accepted here as valid sensu Miller following in this respect Jong and Rogers.[5]

Though originally reported from Ceylon on dead trunks of *Hevea* species, this is the second species of the genus recorded from India. A brief description is given here of this fungus, the first being that of *Penzigia capparidis* (Mundk. and Ahmad) Ahmad.[6]

Penzigia placenta Petch. (Fig. 2) *Ann. Roy. Bot. Gard. Piradeniya*, 8: 142 (1924)

Ascostromata inhabiting the dry twigs of *Artocarpus integrifolia* L. (Moraceae) develops subcortically and emerge out rupturing the bark. The stromata are grayish, dark, rectangular to somewhat irregular in shape with a flat surface, sessile with a broad basal attachment. Perithecia embedded in hard stroma, globose, ostiolate, arranged in a parallel layer, 600-800 μ. Asci cylindrical to clavate, unitunicate, pedicellate with thickened apex provided with an apical canal and pore, octosporous, 200-220 μ × 6-8 μ. Ascospores ellipsoid, dark-brown, thick-walled, uniseriate, 8-10 μ × 4-6 μ, paraphyses and periphyses abundant, filiform slender and hyaline.

On dry twigs of *Artocarpus integrifolia* L. collected at Kumbaladalu, Coorg, Mysore State, 15th May 1969, B. A. Ullasa, M.A.C.S. Herb. No. 1176.

The author is grateful to Prof. M. N. Kamat for his deep interest and guidance. He offers

his grateful thanks to Dr. J. A. von Arx, Director, Centraalbureau Voor Schimmelcultures-Baarn (Netherlands), for helpful suggestions.

Dept. of Mycology and Plant Pathology,
M.A.C.S. Post-Graduate Res. Inst.,
Poona-4, December 28, 1970.
B. A. ULLASA.

---

1. Miller, J. H., *Monographs of Univ. of Puerto Rico*, Series B, 1934, **2**, 195.
2. Martin, P., *Jour. South African Bot.*, 1967, **33**, 205.
3. —, *Ibid.*, 1967, **33**, 315.
4. —, *Ibid.*, 1968, **34**, 153.
5. Jong. S. C. and Rogers, J. D., *Mycologia*, 1970, **62**, 851.
6. Ahmad, S., *Sydowia*, 1948, **2**, 72.

OCCURRENCE OF *FUSARIUM* WILT ON MUSKMELON

Fusarium wilt disease of muskmelon (*Cucumis melo* L.) was observed in *Delta Gold* and *Bangalore* varieties in the varietal collection plots at the Annamalai University Experimental Orchard during September-November 1969 and 1970. The leaves of the affected plants turned yellow and later they lost turgidity resulting in drooping and wilting. The vascular bundles of the roots and stem were black. Deep fissures were formed in the stem at ground level and in the above two internodes (Fig. 1).

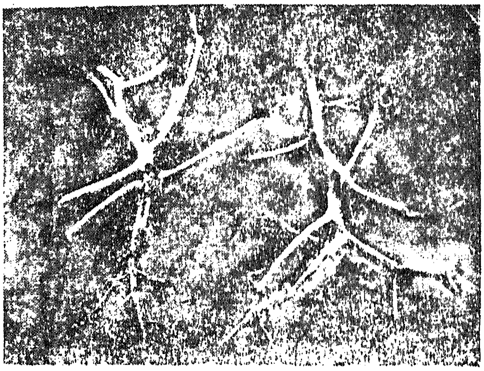


FIG. 1. Stems of the wilted plants showing black streaks and fissures.

The causal organism was isolated on potato dextrose agar (PDA) and the pathogenicity was established on its original host. The fungus produced abundant white aerial mycelium with a flocculent appearance. In PDA, the colour of the submerged mycelium was light cream and in Czapek's agar, yellowish- to brownish-red. The fungus readily produced microconidia in the early stages of growth while macroconidia were observed only in aged cultures exposed to light. Chlamydospores and sclerotia were observed when the fungus was grown in soil extract agar.

Microconidia 1 to 3-celled, 3·8-15 × 1·9-3·7 μ; macroconidia 3 to 5-septate, sickle-shaped, 26·1-39·2 × 2·9-4·2 μ; chlamydospores 1 to 2-celled, terminal or intercalary, 5·7-11·3 × 5·7-8·4 μ; sclerotia dark brown, spherical, 18·0-22·5 μ in diameter (Fig. 2).

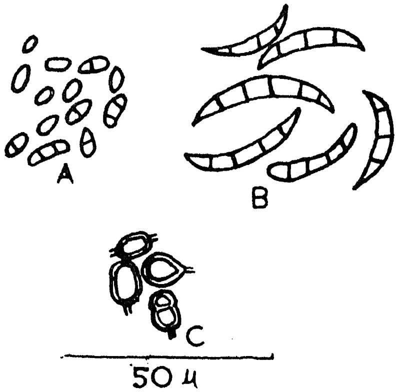


FIG. 2. Microconidia (A), macroconidia (B) and chlamydospores (C) of *Fusarium oxysporum* f. *melonis*.

The fungus was inoculated on different muskmelon varieties, *viz.*, *Meloncella, Kiku, Nambukin, Gin, Schoon's Hard Shell, Long John, Maine Rock, Perlita, Delicious 51, Eiju, Iroquois, Harvest Queen, O'gon No. 9, Dosakaya* and a wild melon [*Cucumis callosus* (Rottl.) Cogn.], following the method of Wensley and McKeen.[1] All the varieties were found to be susceptible except the wild melon.

On comparison, the characteristics of the fungus agreed with *Fusarium oxysporum* f. *melonis*[2-4] and hence the fungus is identified as *Fusarium oxysporum* f. *melonis* (Leach and Currence) Snyder and Hansen.

Microbiol. and Plant Pathology Section,
Faculty of Agriculture,
Annamalai University,
Tamil Nadu, India, December 10, 1970.
R. BHASKARAN.
N. N. PRASAD.
R. KOTHANDARAMAN.

---

1. Wensley, R. N. and McKeen, C. D., *Can. J. Microbiol.*, 1962, **8**, 818.
2. Snyder, W. C. and Hansen, H. N., *Amer. J. Bot.*, 1940, **27**, 64.
3. — and Toussoun, T. A., *Phytopathology*, 1965, **55**, 833.
4. Leach, J. G. and Currence, T. M., *Minn. Univ. Agr. Expt. Sta. Bull.*, 1938, p. 129.

REVIEWS AND NOTICES OF BOOKS

Snake Venoms and Envenomation. Edited by Sherman A. Minton. (Marcel Dekker, Inc., 95, Madison Avenue, New York, N.Y. 10016), 1970. Pp. 343-514. Price $ 8.50.

This is a special issue (Vol. 3, No. 3, September 1970) of *Clinical Toxicology*, official quarterly journal of the American Academy of Clinical Toxicology (annual subscription: $ 25.00). It presents a symposium of nine articles dealing with poisonous snakes, their venoms, and the treatment of their bites. These articles written by active workers in this field of study include identification of poisonous snakes, their salivary glands, the biochemistry and pharmacology of snake venoms, detection of snake venom in tissue, elapid neurotoxins and their mode of action, and the principles of snake bite treatment. Each article is followed by a bibliography of references to original papers.

These authoritative review articles will serve as a source of reference and an introduction to the literature in this field to biologists and physicians. A. S. G.

The Wealth of India: Livestock (Including Poultry). (Publications and Information Directorate, CSIR, Hillside Road, New Delhi-12), 1970. Pp. xiv + 274. Price: Rs. 60·00; *Sh.* 120; $ 18.00.

This volume, issued as a supplement to Vol. VI (L–M) of *The Wealth of India*—Raw Materials Series, deals with all aspects of the livestock wealth of the country, including poultry. The eleven sections of the volume are concerned respectively with cattle, buffaloes, sheep, goats, pigs, horses and ponies, donkeys and mules, camels, yaks, chemistry of livestock products, marketing and trade, and poultry. Some 1,300 selected references are provided, which should be useful as sources of more detailed information to those directly concerned with livestock research and development.

The volume contains six colour plates and 30 text-figures, besides a large number of tables giving statistical data on the topic concerned.

As an authoritative compilation giving valuable information on the subject, this volume should be useful to a variety of readers—research workers, small-scale livestock farmers, entrepreneurs and laymen interested in our useful animal friends which form an essential part of the wealth of India.

A. S. G.

X-Ray and Electron Probe Analysis in Biochemical Research. Edited by K. M. Earle and A. J. Tousimis. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1969. Pp. 105. Price $ 12.50.

This publication is Volume 3 of the series, *Progress in Analytical Chemistry*, based upon the *Eastern Analytical Symposia* (EAS). It contains six papers from the two sessions on X-ray spectroscopy and electron probe analysis as related to biological materials presented at the EAS in November 8–10, 1967. Included in this volume are detailed descriptions of the special specimen handling requirements of biological materials, analytical procedures, and the operational parameters leading to the best results.

A. S. G.

Annual Review of Biochemistry. (Vol. 39). Editor: E. E. Snell. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, USA), 1970. Pp. vii + 1136. Price: USA: $ 13.00; Foreign: $ 13.50.

The rate of growth of research activities in a particular discipline of science is indicated by the inevitable increase in bulk of the volumes of the Annual Reviews Series in that subject. The present volume whose pagination exceeds a thousand is evidence of the intensity of activity currently going on in biochemistry. The prefatory chapter by Professor A. Baird Hastings entitled "A Biochemist's Anabasis", is autobiographical and provides very interesting reading on his career as a biochemist. It contains valuable information concerning his thorough work on acid-base balance and metabolism, and on body calcium and calcification.

The titles in the volume are as follows: 'Quaternary Structure of Proteins', by Irving M. Klotz, Neal R. Langerman and Dennis W. Darnall; 'X-ray Diffraction Studies of Enzymes', by D. M. Blow and T. A. Steitz; 'Specific Chemical Modification of Proteins', by A. N. Glazer; 'The Specificity of Molecular Hybridization Reactions', by Brian J. McCarthy and Robert B. Church; 'The Eukaryotic Chromosome', by John E. Hearst and Michael Botchan; 'Structure and Synthesis of Ribosomal RNA', by Giuseppe Attardi and Francesco Amaldi; 'RNA Sequence Analysis', by P. T. Gilham; 'The Biogenesis of Mitochondria', by Margaret Ashwall and T. S. Work; 'Enzymes of Nucleic Acid Metabolism', by James F. Koerner; 'Lipid Chemistry', by Morris Kates and M. K. Wassef; 'Lipid Metabolism', by W. J. Lennarz; 'Photosynthesis', by D. A. Walker and A. R. Crofts; 'Multienzyme Systems', by A. Ginsburg and E. R. Stadtman; 'Computer Application to Biochemical Kinetics', by David Garfinkel, Lillian Garfinkel, Martin Pring, Sylvan B. Green and Britton Chance; 'Hypothalmic Releasing Factors', by Roger Burgus and Roger Guillemin; 'The Biochemistry of RNA Bacteriophage Replication', by R. L. Stavis and J. T. August; 'Transport', by H. R. Kaback; 'Glycoproteins', by R. G. Spiro; 'Glycogen Metabolism and Glycolytic Enzymes', by Carlos Villar Palasi and Joseph Larner; 'Bacterial Cytochromes: I. Structural Aspects, by M. D. Kamen and T. Horio; 'Oncogenic Viruses', by Maurice Green; 'Mechanism of Biotin Action', by J. Knappe; 'Neurochemistry at the Crossroads of Neurobiology', by Eugene Roberts and Steven Matthysse; 'Biochemistry of Addiction', by Vincent P. Dole; 'Chemical Synthesis of Peptides and Proteins', by A. Marglin and R. B. Merrifield; 'Flavoenzyme Catalysis', by Allen H. Neims and Leslie Hellerman; 'The Antigen Receptor Problem', by Henry Metzger; 'Control of Enzyme Levels in Animal Tissues', by Robert T. Schimke and Dorrell Doyle; and 'Hemoglobin', by Eraldo Antomini and Maurizio Brunori.

A. S. G.

The NMR of Polymers. By I. Ya. Slonim and A. N. Lyubimov. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011, U.S.A.), 1970. Pp. x + 365, Price $ 19.50.

Nuclear Magnetic Resonance is a rapidly developing field of study in polymer chemistry, and with the refinement of experimental techniques going side by side with improvement in theory, new progress has been achieved especially in the NMR spectroscopy of polymer solutions. The book under review gives a systematic account of published work on high polymers NMR.

The book is in two parts. Part I is theoretical and gives the fundamentals of the physics and mathematics of NMR. It also contains the principles of construction of NMR spectrometers, and methods of receiving and interpreting spectra. Part II gives a review of papers on NMR high polymers published through 1963.

The Russian original of this English translation was published in 1966, but it has been corrected by the authors for this edition and updated in respect of literature cited to cover up to 1967.

The book will be very useful to analytical, organic and polymer chemists and applied spectroscopists.

A. S. G.

Volcanism and the Upper Mantle—Investigations in the Kurile Island Arc. By Georgii S. Gorshkov. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011, U.S.A.), 1970. Pp. xv + 385. Price $ 35.00.

A close study of volcanism and the volcanic regions of the earth gives fundamental clues to geological processes involved in the earth's history. The origin and development of volcanic island arcs have attracted the attention of geologists in recent decades, for it is here that conversion of one type of terrestrial crust to another takes place.

The Kurile Islands chain, consisting of 16 more or less large islands and a series of rocks, extends over 1,150 km and connects, so to speak, the southern tip of Kamchatka and the northern tip of the Japanese island Hokkaido, separating the more epeiric Sea of Okhotsk from the Pacific Ocean. The Kurile arc, along with Kamchatka, is known to be the most seismic region of the USSR.

The author, Dr. Gorshkov, is the Director of the Institute of Valcanology in Kamchatka which is under the Siberian Branch of the USSR Academy of Sciences. The book presents the results of the volcanological investigations carried out by him and his team of scientists over a period of nearly two decades (1946-1964).

The contents of the monograph may be divided into three parts. The first part of four chapters (pages 1-48) gives briefly a description of the Kurile island arc, basic information on the history of volcanic investigations in this region, the submarine relief, and the geology of the basement. The second part which forms the main portion of the book is Chapter V (pages 49-234), which describes in detail the volcanoes investigated in this region. In all, 160 quaternary terrestrial volcanoes and volcanic groups are described. Of these, 104 have been active in the Holocene (late glacial, 10-11 thousand years), and among the new volcanoes added to the list are some active ones.

The third part, Chapters VI-VIII (pages 235-248) is devoted to an account of factual material on the petrochemistry of the volcanic rocks and the comparison of the petrochemical features of the Kurile rocks with those of other island arcs, Pacific as well as in other regions. The author also discusses the evolution of volcanism as a reflection of the evolution of the upper mantle and the crust.

This monograph in the geoscience series is an important addition to the literature on the subject as it includes much new material not so far published. A. S. G.

Food and Man. By Miriam E. Lowenberg, E. Neige Todhunter Eva D. Wilson, Moria C. Feeney and Jane R. Savage. (Published by Wiley Eastern Private Ltd., J. 41, South Extension, New Delhi-49), 1970. Pp. ix + 341. Price Rs. 4·50.

Many colleges in America offer general courses in Foods and Nutrition to meet the needs of students in home economics and allied areas of study. The authors who have taught such courses in different colleges have pooled their experience and joined together in bringing out this extremely readable and informative text on the subject under the title *Food and Man* which will be of interest to the general reader also besides the students of home economics and home science for whom it is intended. The book is non-technical and can be understood even by those with no background knowledge of physics or chemistry.

The topics chosen are concerned with food in historical perspective; food habits and food ways; food and its relation to culture and to the major religions of the world like Christianity, Judaism, Islam, Hinduism and Buddhism; hunger, malnutrition and diseases; nutritional challenges of the future; and organizations and programs to improve nutrition.

The book is liberally illustrated with pictures, tables and maps, and has been produced at low cost as a Wiley Eastern reprint.

A. S. G.

Books Received

Annual Review of Phytopathology. (Vol. 8). (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California, U.S.A.), 1970. Pp. vii + 480. Price U.S.A.: $ 10.00; Foreign: $ 10.50.

Annual Review of Nuclear Science (Vol. 20). (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306), 1970. Pp. vii + 613. Price U.S.A.: $ 10.00; Elsewhere: $ 10.50.

Annotated Bibliography on Forest Influences and Watershed Management Research in India. By I. M. Qureshi, B. K. Subba Rao, B. G. Dabral and Vidya Sagar. (The Directorate of Forestry Research, Forest Research Institute and Colleges, New Forest, Dehra Dun), 1970. Pp. viii + 127. Price not given.

Biochemistry Laboratory Techniques. By S. Chaykin. (Wiley Eastern P. Ltd., J. 41, South Extension, New Delhi-49), 1970. Pp. vii + 169. Price Rs. 10·00.

Fundamentals of Automatic Control. By S. C. Gupta and L. Hasdoff. (Wiley Eastern P. Ltd., J. 41, South Extension, New Delhi-49), 1970. Pp. xv + 583. Price Rs. 27.

Current Science is the Premier Science Fortnightly of India published by the Current Science Association, Bangalore, and issued on the 5th and 20th of each month. All material intended for publication in CURRENT SCIENCE (Articles not exceeding 2,000 words and Letters not exceeding 500 words, with brief abstracts and minimum number of illustrations to stand column size reduction) and books for review should be addressed to the Editor, *Current Science,* Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, reprints, exchange journals, etc., should be addressed to the Manager, Current Science Association, Raman Research Institute, Bangalore-6.

Subscription Rates: India: Rs. 24; Foreign: £3-0-0, $ 8.00.

2654-71. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.

THEORY OF POROUS ELECTRODE OPERATIONS

S. K. RANGARAJAN

Homi Bhabha Fellow, National Aeronautical Laboratory, Bangalore-17

1. ELECTROCHEMICAL energy conversion devices (and especially those with high-energy density applications) employ porous electrodes extensively. Be it a primary battery like silver-zinc or a storage device as lead-acid (or nickel-cadmium) or certain important fuel cells, electrodes with a high specific surface as offered by porous media are needed. This is essentially because the electrode current attainable under given conditions is not only a function of the potential but is also dependent on the extent of the surface available for the electrochemical reactions to take place. Since in many cases the reactions that are otherwise desirable may be very slow to proceed, the rate of the reaction is more conveniently enhanced to the required extent by an nincrease in the area factor. And so the porous electrodes that are able to provide a large active surface area become well-nigh indispensable. But this same factor, *viz.*, an effective pore wall surface, introduces difficulties in the operations in the form of limitations due to associated phenomena like mass transfer, charge transport, etc. It is as if some of the advantages are lost on the way. A theoretical formulation of such real system operations is obviously a formidable task. We discuss below types of simplifications introduced in the models—their nature and their motivation.

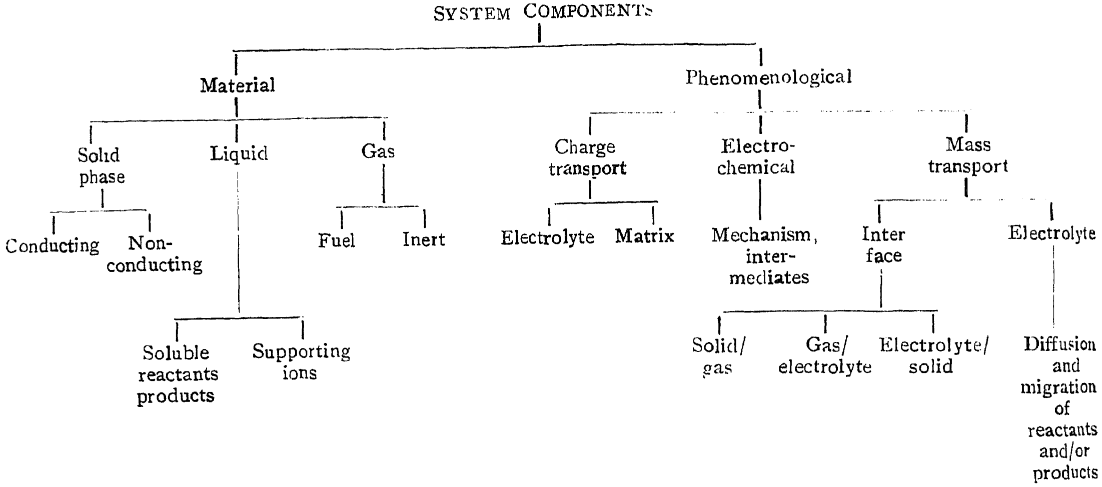
A porous body can be viewed as a medium wherein particles (or voids) are distributed in a random or ordered fashion. The many parameters defined to characterise real porous systems—pore diameter being one of them—do not assume unique values and are always *distributed* around one or more modes representing their averages. This is true even for single-particle materials, *viz.*, those composed entirely of particles of the same kind like carbon powder or platinum black, for there can be at least two effective radii indicating the nature of particle *distribution* and the particle *composition*. But many porous media used as electrodes have—on optimum-design considerations—differing pore-diameter structures linked together as, for example, in dual porosity models, thereby introducing another type of non-homogeneity. Further, with a view to obtaining, certain required characteristics like non-wetting, conduction, etc., it may be considered desirable to include certain metallic or non-metallic agents like Pt. black or teflon in this process thereby making the nature of a real porous matrix much involved.

The reactants can be fed in the gaseous state or as species soluble in the electrolyte. Thus a porous electrode while operating has to contend with the phenomena associated with all the three phases and hence with the corresponding interfaces, since the electrochemical reaction is heterogeneous. Thus the *material* components of the system, *viz.*, the solid particles, the possible gaseous fuel, the electrolyte carrying the currents, etc., interact in a region whose geometry is complex and difficult to describe. To know the system performance, we have to know the *phenomenological* components as well (Table I). It is well known, for example, that: (*i*) the finite conductivity of the electrolyte and, in some cases, of the matrix as well, (*ii*) the finite rate of charge transfer reaction, and (*iii*) the mass transport of the reactants and products (and intermediates) can all cause the so-called polarisation effects, offsetting at least partly the advantages of employing porous electrodes. In other words, operating with a high specific surface area medium like the porous body creates its own problems. A limiting rate on the performance may result from any one of the above, *viz.*, the conductivity, velocity of the electrochemical reaction or rate of mass transfer being very small. Included in the above category are events like transport across gas/electrolyte interface, adsorption on solid surface, and diffusion or migration to catalytic sites on the surface of the metal. Hence, it follows that the information relevant to porous electrode operations like: (*a*) limiting current densities attainable, (*b*) regions that contribute effectively to the overall rate of reaction, (*c*) the potential distributions inside the electrode, etc., is closely related to the interplay of the phenomenological components outlined above.

2. An exact theoretical analysis of this system is rendered impossible mainly by the following factors; (*a*) the structural details of

TABLE I

Porous electrode operations


SYSTEM COMPONENTS
Material
Phenomenological
Solid phase
Liquid
Gas
Conducting
Non-conducting
Soluble reactants products
Supporting ions
Fuel
Inert
Charge transport
Electro-chemical
Mass transport
Electrolyte
Matrix
Mechanism, inter-mediates
Inter face
Electrolyte
Solid/gas
Gas/electrolyte
Electrolyte/solid
Diffusion and migration of reactants and/or products

the internal surface of the porous body are not known precisely, (*b*) the equations describing the mass transport and the potential variations are not only non-linear and multidimensional but are also simultaneous, and (*c*) the problem of defining the geometry of the three-phase boundaries—the so-called active regions—where the reaction rates may be significant, is similar to the uncertainty posed by (*a*) but of a different category. To circumvent the above, idealisations of various sorts are resorted to.

Firstly, the problem (*a*) suggests—at one end—that real structures may be idealised as parallel, cylindrical or of lattice-type (or similar ones with manageable symmetry) for purposes of theoretical analysis. On the other extreme, we find a completely statistical description also useful.

Secondly, to avoid the pursuit after solutions of multidimensional non-linear equations, a reduction in the number of dimensions (mathematical) is achieved by a clever, though suspicious, homogenisation. The third difficulty, *viz.*, the local geometry of the three phases (in contrast to the overall cell geometry or even macroscopic geometry of the porous media)—is again idealised. To sum up, attempts to avoid the cumbersome aspects of porous electrode operations, *viz.*, the porous structure, multidimensional equations and the multiphase geometry, have been three-pronged and the above three approaches may be judiciously combined to formulate models to explain the behaviour of porous electrodes.

3. Several models for describing the operation of gas-diffusion electrodes are now available and it is not surprising if many more are being studied. There are at least three reasons why such diverse models are currently studied. Firstly, the *designs of gas-electrodes* for a given set of operating conditions can be so different that a single model is unlikely to explain the operations of all these. For example, single and multiple-layer structures, apart from those with randomised distribution of micro and macro pores are currently in use. Why should one particular type of idealisation suit all these ? Secondly, the electrochemically active regions of such gas electrodes are determined by the so-called three-phase boundaries with attendant uncertainties as regards the geometry, mode of transport of certain reactants to the reaction sites (and the removal of products) and the mechanism of the reaction in such a region. All these, in turn, suggest different types of approaches to this solution. Lastly, the *operating regimes* of such electrodes in terms of the parameters like temperature, pressure, the nature of the electrolyte, etc., can be so varied that a particular model may be unacceptable for a particular choice of these variables but still be valid under a different condition.

4. A classification of these models into several groups dictated by considerations such as those mentioned earlier may be attempted as follows :

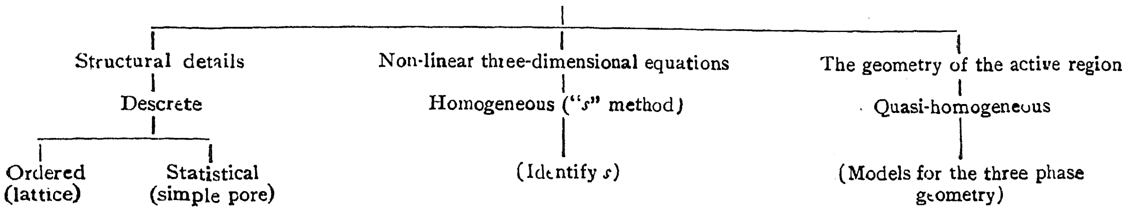
(A) Homogeneous ;

(B) Quasi-homogeneous ; and

(C) Statistical or discrete models (*see* Table II).

TABLE II

Theory of porous electrode operations


Structural details
Descrete
Ordered (lattice)
Statistical (simple pore)
Non-linear three-dimensional equations
Homogeneous ("s" method)
(Identify s)
The geometry of the active region
Quasi-homogeneous
(Models for the three phase geometry)

(A) A homogeneous picture of the gas-diffusion electrodes solves the multi-dimensional difficulties posed by the real system by reducing the number of space variables considered. In effect, this implies that we view the interconnected multi-phase system as a *single* homogeneous phase. This reduces the complexities of analysis enormously and provides us an insight into the phenomena. What the well-known homogeneous model for the flooded porous electrodes—the two-phase porous electrode/electrolyte system—does is to replace the distributed heterogeneous sources/sinks by appropriate homogeneous or *volume* entities. [*See* for example, E. A. Grens. II and C. W. Tobias, *Ber. Bunsenges. Physik. Chem.*, 68 (1964), 236, R. de Levie, *Adv. Electrochem., Electro Chem. Eng.*, 4 (1967).] A similar, direct, reduction of the three-phase gas-electrode/electrolyte problem to a flooded version can be done and hence a corresponding homogeneous picture emerges. In such an approach, we are not obliged to handle the structural details of the porous matrix *directly* nor is there a need to know the geometries of the active sites explicitly.

In the elementary flooded pore model, the homogenisation was more straightforward. This was achieved by assuming a local current density-potential relationship, $i = f(\eta)$ and the transformation of the surface (amp/cm^2) to volume (amp/cm^3) sources (or sinks) was effected by replacing i by $s.i.$ and setting up the relevant differential equations (the parameter s signifying the specific surface of matrix cm^2/cm^3). Such a procedure is easy to comprehend as the electrochemical reaction takes place (though with different rates) along the entire (internal) surface (of the porous medium) and hence the presence of the specific surface in the expression for the sources is understandable. With a three-phase system, one may still introduce s as was done earlier in the flooded-porous medium but its meaning is less precise now since we may not be able to identify it with the total internal surface. The interpretation of s is closely linked with our description of the reaction mechanism. Homogeneous models with the following variations have been proposed for the gas-filled electrodes :

(Aa) s : total internal electrode surface—same as in the flooded-porous model—this description is expected to be fairly accurate for gas content of the order of 80% : O. S. Ksenzhak.

(Ab) *Macroporosity* : internal surface of wide pores—valid if wetting of macropores by a film of electrolyte is possible : A. G. Pschenichnikov.

(Ac) *Common area* between the gas and liquid ; this may be evaluated if the pore-distribution statistics are known : V. S. Markin *et al.*

[Refer *Fuel Cells—Their Electrochemical Kinetics.* Ed. V. S. Bagotskii and Yu. B. Vasilev, Consultants Bureau (1966), New York.]

In all the above, the parameter s is a body-characteristic that may depend upon the gas pressure *via* r_c, the critical radius that decides which of the pores will be flooded. More generally, s may be any empirical parameter that is capable of being defined *a priori* in terms of the structural and equilibrium properties of the porous medium alone. It follows therefore that for analysing gas-electrode operations through the above models, we can use the same mathematical apparatus studied in detail for the flooded-porous systems except that different meanings may have to be attributed to some of the parameters. Moreover, once the relationship of the constants like s to the structure properties are made explicit as in A(*a*)–A(*c*), the mathematical solutions are well-poised for being verified for their predicted dependence on structure constants and variables like gas pressure, etc.

5. (B) The second class of models, *viz.*, quasi-homogeneous attempt to simplify the problem stagewise. Firstly, the regions (active) as regards the electrochemical reaction and the *geometry of the three-phase* region are idealised. Appropriate equations are formulated keeping in view the details of the mass and charge transport associated with the proposed geometry and the reaction mechanism. A solution of these equations gives us, then, the local strength of the sources/sinks. This is carried over properly to be imbedded in a homogeneous model, incorporating also the phenomena of mass and charge conduction in the rest of the porous body. Essentially, therefore, the two stages in this modelling are: (*i*) a model for the three-phase boundaries and the phenomena occurring therein, and (*ii*) relating the results of (*i*) to the results concerning the porous body *via* homogenisation and a knowledge of the overall distribution of such boundaries. Variations in this class of models arise due to the plurality of descriptions possible in both (*i*) and (*ii*). The structure of the three-phase region and the impact of this on the potential or activity distributions therein have been the concern of many workers. But, compared to this, the methodology of transforming these results to the real problem of obtaining results for the porous body has engaged much less attention. [For an outline of some of the three-phase geometries, refer: *Fuel Cells and Fuel Batteries*, by H. A. Liebhafsky and E. J. Cairns, Wiley (1968), and *Fuel Cells—Their Electrochemistry* by John Bockris and S. Srinivasan, McGraw-Hill (1969).]

6. Another ideal approach lies in not ignoring the structure as in the previous approaches but in idealising it. Two elementary models falling under this classification are:

(*a*) Single-pore approach, and

(*b*) Lattice or cell method.

(*a*) The former assumes non-intersecting pores as constituting the system and assumes at least two parameters r and δ, r denoting the radius of a typical solid capillary and the other, *viz.*, δ as a distance-parameter representing the packing of such solids. The *exact* boundary value problem is then solved taking into account the geometry of the pores and its environment. The results deduced for this model will no doubt be functions of r and δ and the averaging over the proper ensemble leads to the results relevant to the overall medium. The methodology is pseudo-deterministic and can be expected to yield at least a qualitative solution to the problem.

The complementary case, *viz.*, non-connected cylindrical voids imbedded in a solid matrix, is well known and is simpler. This approach may be useful while one wants to study specific pore size effects like those of varying thickness, etc.

(*b*) The cell or lattice model is especially useful for studying an interconnected pore-medium. In its simplest form, this too depends on two parameters as the single-pore approach but should be viewed now as some sort of a cascade process where each unit cell alters the flux that should be fed on to the next. As before, there is always a probabilistic factor involved in these arguments and should not be lost sight of.

The above two approaches represent the two extremes of the spectra of possible designs for porous matrix. To the author's knowledge, more investigations on these lines are needed. (This is not to be confused with the structure-model-approach which defines the capillary equilibrium or relates effective parameters like r_e, s, etc., to the structure. What we imply here is a complete discretisation, *i.e.*, that which includes the mass transfer effects, etc., also.)

7. From what has been examined in this paper thus far, a few questions emerge:

(*a*) If the mathematical modelling does not bear a one-to-one relationship with the physical nature of the phenomenon, how do we compare the models? When are these pictures distinct and when do they merge with each other?

(*b*) Is it possible that new models may be postulated, improving (or disproving) the earlier ones as evidenced through the experimental results with, let us say, the oxygen electrodes?

(*c*) Though the detailed structure of the porous medium is ignored in the models, certain appropriate system parameters are introduced to account effectively for this deviation from reality. How are these effective parameters dependant on the porous *structure*? For example, what can be said of the structure of the interphase boundaries (liquid-gas) inside the porous body or of the capillary equilibrium?

(*d*) What are the perspectives as regards the types (and the design) of electrodes and the techniques to be employed in such studies? These questions were taken up during a recent symposium organised by the SAEST at Karaikudi.

(*a*) S. K. Rangarajan, besides reviewing critically the present state of the theory of porous electrodes, presented some results concerning the application of comparison theorems to the non-linear equations arising in this topic and also the transient analysis of such systems.

(*b*) K. Micka (Heyrovsky Institute of Polarography, Prague) presented experimental results to substantiate his model of porous electrodes of second order that considers, apart from the usual two systems of pores (larger gas-pores and smaller flooded-pores), very fine pores due to the catalyst particles and flooded with electrolyte.

The problem of relating the local current density potential relationship (micro-kinetic) to the experimentally accessible current-potential curves (macro-kinetics) in the flooded porous system, assuming limitations due to the mass transfer of the reactants and products was discussed in detail by I. G. Gurevich (Heat and Mass Transfer Institute, Minsk, USSR).

(*c*) The statistical aspects of the capillary equilibrium as a basis for test of models was considered by Yu. A. Chimadzhev (Academy of Sciences, USSR).

(*d*) M. Bonnemay and G. Bronoel (Laboratorie d'electrolyse du CNRS, France) discussed about the triple contact electrodes and the possible future role of dispersed or suspension electrodes in electrochemical power sources. The need to tackle urgently the problems of education, training (and attitude) and needed directions in basic research as well as perspectives on the future of electrochemical energy conversion and storage were stressed by J. O. M. Bockris in his address (Tables III and IV).

TABLE III

(due to J. O. M. Bockris)

Some peculiar priorities (1969 $ *millions*)

Battery Research—All U.S.	..	5
Fundamental Electrochemistry—Research	..	1
G.M. Anti-Pollution Research	..	8
N.A.P.C.A. Total Budget	..	112
G.M. Advertising	..	240
Model Change, Car Companies	..	2000

TABLE IV

(due to J. O. M. Bockris)

Some peculiar priorities

(Ph.D.'s per year)

All Chemistry	..	c. 2000	(U.S.)
Electrochemistry (1969)	..	5	(U.S.)
		10	(U.K.)
		26	(Germany)
		52	(U.S.S.R.)*

* Equating Kandidat degrees to U.S. Ph.D.

ACKNOWLEDGMENT

The author thanks the Homi Bhabha Fellowship Council for financial support, and Prof. S. Ramaseshan for his keen interest in this work.

SOIL-BASED IRRIGATION FOR MAXIMISATION OF CROP YIELDS WITH A GIVEN UNIT OF WATER

C. DAKSHINAMURTI AND D. SUBBARAMI REDDY

Division of Agricultural Physics, Indian Agricultural Research Institute, New Delhi, India

IT is well known that over 35% of the irrigated lands of the world have either turned saline or alkali, due mostly to injudicious irrigation and inadequate drainage (Dakshinamurti, 1962). Irrigation water has become a precious commodity all over the world, more so in the tropics and developing countries. Although extensive investigations have been carried out on the irrigation requirements of crops, the concept has all through been in supplying certain quantities of water based mostly on the agronomic observation of the water requirements of crops. The water-holding capacity of the soil which plays an important role in preserving the water and supplying it to the user —the plant, has never been kept in mind. This resulted mostly in the loss of water by percolation and leaching of nutrients from the soil. It is, therefore, thought desirable in the present investigation to find out the amount of water held in the first 30 cm of the root zone at the field capacity and give new concept to the quantum of irrigation water given per hectare.

Two promising varieties of wheat, namely, Sarbati Sonara, a two gene dwarf and H.D.

1955, a triple gene dwarf, were grown on a statistically-laid field experiment on alluvial soil of the Indian Agricultural Research Institute Farm, New Delhi. Optimum doses of fertilisers, as recommended by the Agronomy Division, were used in the present investigation. Four irrigations, including an irrigation at the crown root stage, as recommended by the irrigation specialists, were given during the crop growth. At each stage of irrigation, the quantity of water given varied from ½ field capacity to three times field capacity at six levels, namely, ½, ¾, 1, 3/2, 2 and 3 times field capacity values respectively. Controlled field with no irrigation, except the pre-sowing irrigation, was kept side by side.

Figure 1 gives the grain yield of Sarbati Sonara in quintals per hectare obtained with different quantities of irrigation water given. It may be seen from the figure that the yields were highest between ¾ field capacity and one field capacity of irrigation water given.

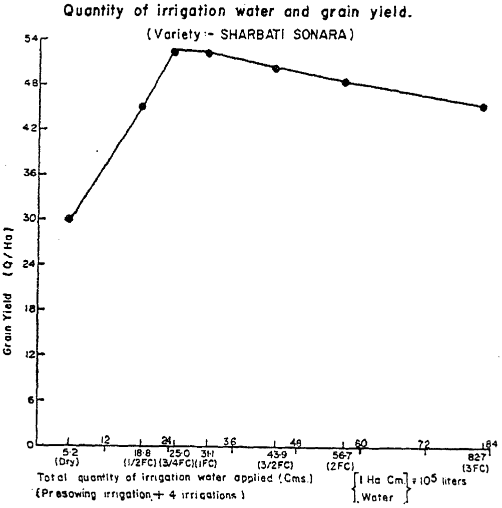

Quantity of irrigation water and grain yield.
(Variety :- SHARBATI SONARA)

FIG. 1

Figure 2 gives the yield of triple gene dwarf under similar conditions of irrigation given. The results are almost the same as in the case of Sarbati Sonara, namely, that between ¾ field capacity and 1 field capacity of irrigation water given, the yields reached the maximum value.

It appears from Figs. 1 and 2 that the capacity of the soil to hold the water and hand it over to the plant is more important in maximising yields than the variety of the species, although they are known to have their own characteristic root pattern (Dakshinamurti, 1969; Subbiah *et al.*, 1968). Irrigation rate at three times field capacity has done more harm to the soil and crop than good. This amount of water, if distributed at the rate of ¾ field capacity, can easily cover about four times the cropped area with higher yields per hectare. Thus, if it is required to maximize the yields with a given unit of water, it seems necessary to take that much of area for cropping on which the irrigation can be given each time at the rate of ¾ field capacity of the soil. Thus, knowing the soil characteristics, it is now possible to allot the area of cropping for maximisation of yields with a unit quantity of water given.

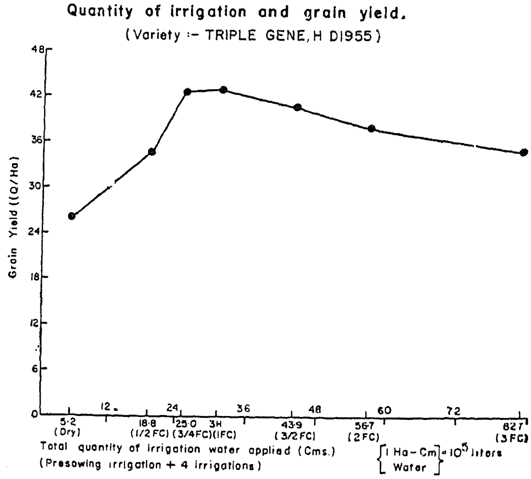

Quantity of irrigation and grain yield.
(Variety :- TRIPLE GENE, H D1955)

FIG. 2

A question naturally arises, how the fertiliser is being distributed in the root zone under the different quantities of irrigation water given? Figure 3 gives the mineralisable nitro-

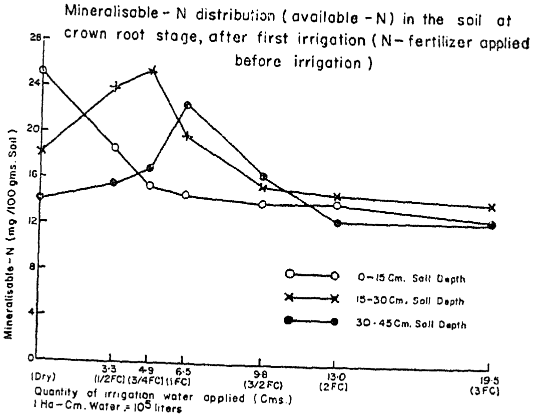

Mineralisable - N distribution (available - N) in the soil at crown root stage, after first irrigation (N-fertilizer applied before irrigation)

FIG. 3

gen distribution in the soil at crown root stage after the first irrigation. It is seen from the figure that at ¾ field capacity irrigation rate, the mineralisable nitrogen in the 0-15 cm top layer decreases by leaching to about half the original value of nitrogen, while this leached nitrogen gets accumulated in the 15-30 cm layer. At 30-45 cm soil depth, the mineralisable nitrogen has a maximum value at one field capacity level of irrigation water given. For higher values of irrigation rates, the nitrogen gets lost from the root zone. In the case of wheat, about 60% of the root system is known to spread mostly between 15-30 cm depth and about 20% extend to the subsoil region 30-45 cm (Arora, 1969). If the irrigation schedules are restricted to ¾ field capacity and one field capacity, most of the mineralisable nitrogen will be available to the roots resulting in maximisation of yields.

Further work on the benefits of water harvesting technology coupled with irrigation schedules based on soil characteristics is in progress.

The authors acknowledge their grateful thanks to Dr. M. S. Swaminathan, Director, Indian Agricultural Research Institute, New Delhi, for his continued interest in this investigation. They are also grateful to Dr. A. M. Michael and Dr. N. G. Dastane for their helpful discussions.

---

1. Arora, R. P., *Ph.D Thesis*, I.A.R.I., New Delhi, **1969**.
2. Dakshinamurti, G., *Seminar on Salinity and Alkali Soil Problems*, I.A.R.I., New Delhi, **1962**.
3. —, *Technical Report No. 113*, I.A.E.A, Vienna, 1969, p. 28.
4. Subbiah, B. V., Katyal, J. C., Narsimham, R. L. and Dakshinamurti, C., *International Journal of Applied Radiation and Isotope*, **1968**, **19**, 385.

INFECTIOUS BURSAL DISEASE IN CHICKENS

G. C. MOHANTY, A. P. PANDEY AND B. S. RAJYA
Division of Pathology, Indian Veterinary Research Institute, Izatnagar, U.P.

INTRODUCTION

INFECTIOUS bursal disease (IBD) is a viral disease generally affecting young birds upto six weeks of age causing high morbidity but low mortality. Infectious bursal disease or "Gumboro disease" was first recognized and reported in the U.S.A. by Cosgrove (1962) in 1957. Winterfield *et al.* (1962) have isolated the infective agent and differentiated it from the nephrosis syndrome caused by certain variant strains of infectious bronchitis virus (1962). Subsequently, the disease has been reported from U.K. (Barron, 1966), Israel (Meroz, 1966), Germany (Landgraf *et al.*, 1967), Netherland (Lensing, 1968), Spain (Badiola *et al.*, 1969), France (Maire *et al.*, 1969), and Puerto Rico (Bond *et al.*, 1970). Report on the occurrence of this malady in Asiatic countries including India is not available in the literature.

The present report deals with the occurrence of IBD in India and patho-anatomical changes encountered in natural and experimental cases.

MATERIALS AND EXPERIMENTAL PROCEDURE

During routine post-mortem examinations and materials received from the field, several specimens of bursa Fabricius were collected usually from young growing birds of about 3 to 6 weeks of age. A few specimens of bursa Fabricius were collected aseptically and a 10% saline suspension was made of the involved bursa. The suspension was either filtered through bacteriological filters or treated with antibiotics (10,000 units of penicillin and 10 mg of streptomycin per ml of the bursal suspension) before inoculation into the susceptible chicks. Three-week-old chicks were inoculated intraperitoneally with 0·2 ml of treated material and simultaneously given a drop of inoculum on the eyes and nostrils and eight serial passages were done. Nine-day-old embryonated eggs were inoculated *via* allantoic cavity with the treated bursal suspension and five serial passages were done using whole embryo suspension.

Parts of the bursa Fabricius from natural cases as well as from experimentally-infected birds were fixed in 10% formal-saline and processed for routine hematoxylin and eosin staining (H.E.). Histochemical staining was done for the presence of mucin and connective tissue by Alcian blue and periodic acid schiff reaction (PAS) and Masson's trichrome staining technique respectively, in a few selected sections. Seventy-one natural cases and 213 experimentally-inoculated cases were studied for pathologic changes.

RESULTS

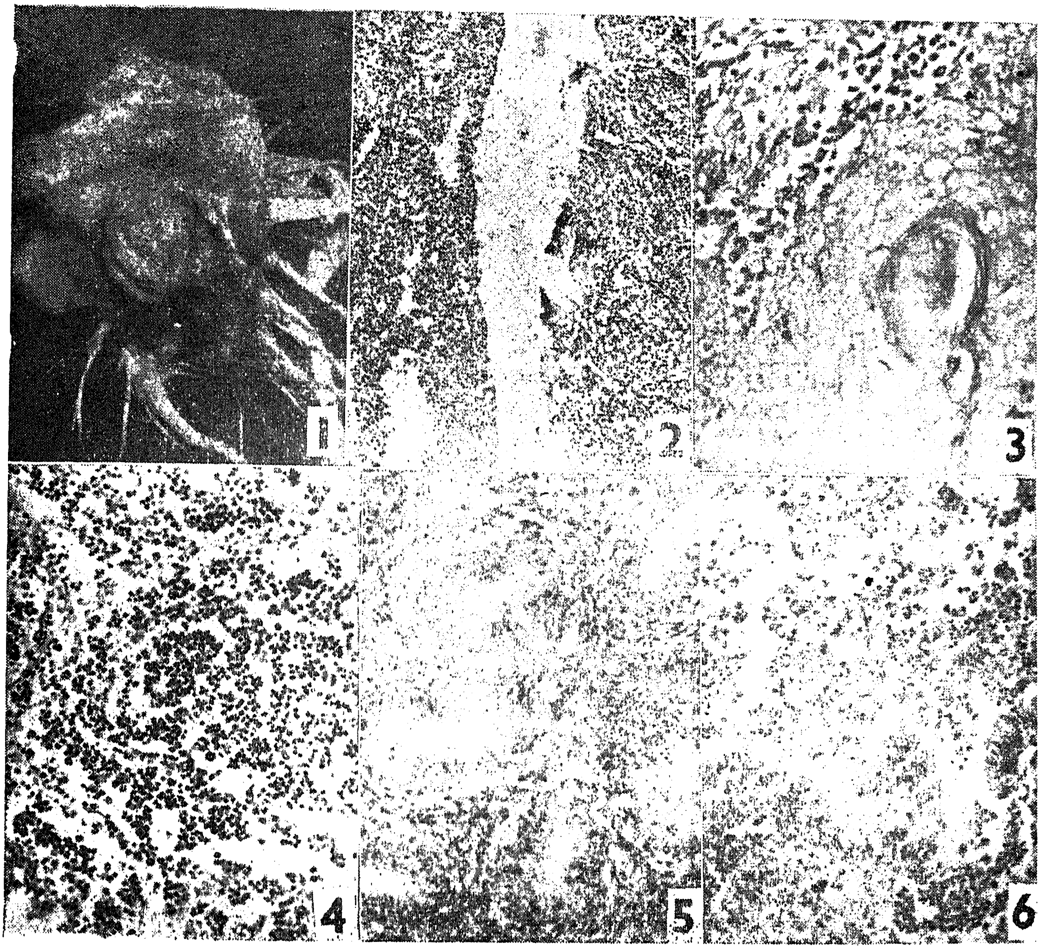
Clinical signs.—Comprised of ruffled feathers, dullness, depression and poor growth occasionally associated with diarrhoea as evidenced by soiled vent feathers in natural cases. Experimentally clinical signs were evident on 2nd day after 3 serial passages. Dullness and depression were the main clinical signs and death occurred on the 3rd or 4th day post-inoculation (PI). Mortality rate varied from about 5% to 12% but morbidity rate was little over 80% after 5 serial passages in 3-week-old chicks.

Gross pathology.—Enlargement with prominent striations and discolouration of bursa Fabricius were noticed in some of the naturally-infected birds and on excision, a gelatinous material was often present inside the bursa. Atrophy of bursa with accumulation of yellowish caseous materials was also seen in a few birds but generally in advanced cases. Birds with bursal lesions were having stunted growth and poor musculature. A few cases also had nephrotic lesions or congestion of kidneys. Intramuscular haemorrhages were often present and thigh musculatures were commonly involved. Occasionally, a few cases of focal hepatic necrosis were associated with bursal lesions. Gross changes in the experimentally-inoculated chicks were usually confined to the bursa. Swelling with prominent striations (Fig. 1) and discolouration of bursa were noticed starting from 2nd day post-inoculation (PI) and continues usually upto 8 to 10 days PI. Slimy materials were often noticed on incision of these swollen bursae. But presence of caseous core and flakes were usually noticed after 12 to 15 days PI associated with variable degrees of bursal atrophy. Lesions in other organs comprised of nephrosis with or without distention of ureters with urates and muscular haemorrhages in a few cases.

Microscopic pathology.—Variable degrees of necrotic and proliferative changes were seen in natural cases. Lesions of short duration comprised of lymphoid necrosis and proliferation of reticular cells and cortico-medullary epithelium. Heterophilic infiltration mixed with mono-nuclear cells was evident in lymphoid follicles as well as in interstitial tissue and mucosa of the bursa Fabricius. Vascular congestion was seen in many cases. In severely-affected cases, most of the lymphoid tissues were destroyed and there was heavy infiltration of heterophils along with presence of caseonectotic debris in the bursal fold mixed with degenerated heterophils and detached epithelial cells (Fig. 2). Cases with longer duration had hyperplastic and metaplastic changes in the lining epithelium. Proliferation of endodermal epithelial cells down into the interstitial tissue forming serous, mucous and mixed glandular structures was seen in many cases. Proliferation of lining epithelial cells and metaplasia into stratified squamous epithelium of several layers with and without presence of keratin were noticed in a few cases (Fig. 3). Focal metaplasia of epithelial lining cells into mucous-secreting glands was evident in many areas with formation of cyst-like cavities in the mucosa. Most of the cases exhibit variable degrees of fibroplasia with accumulation of mononuclear cells mixed with a few heterophila in the interstitial tissue.

Bursal atrophy with almost complete depletion of lymphocytes was seen in cases of prolonged duration. Whole bursa in most cases was converted into a sac-like structure filled with a caseous core. Proliferative and metaplastic changes were more pronounced with formation of keratin in most cases. Fibroplasia with accumulation of mononuclear cells mixed with degenerated lymphocytes and a few heterophils was marked in the interstitial tissue. Presence of cysts lined with a single layer of cuboidal to flat epithelium was seen in many sections associated with thickened bursal capsule.

Early histopathological changes (3 days PI) in experimentally-inoculated birds comprised of lymphoid necrosis. Accumulation of heterophils in the lymphoid follicles, interstitial tissue and in the mucosa associated with edema, congestion, vacuolar and hyperplastic changes of lining epithelium was evident (Fig. 4). Proliferation of reticular cells and endodermal epithelial cells with accumulation of a few blast cells and plasma cells in the lymphoid follicles was noticed in cases destroyed 6 to 8 days PI. Metaplasia of lining epithelial cells into mucous-secreting glands was seen in most cases. Birds destroyed 10 days PI revealed complete or partial replacement of lymphoid follicles with proliferation of endodermal epithelial cells and formation of gland-like structures in focal areas (Fig. 5). Some cases destroyed 7 to 15 days PI revealed presence of caseous core with accumulation of necrotic debris, desquamated epithelial cells and abundance of degenerated heterophils (Fig. 6). Fibroplasia with accumulation of mononuclear cells and a few heterophils was prominent in the interstitial tissue. Fibroplasia and destruction of bursa were not so prominent as in natural cases of long duration.



FIGS. 1–6. Fig. 1. Bursa showing swelling and striations from an experimentally inoculated chick (5 days post-inoculation). Fig. 2. Section of a naturally infected bursa showing degeneration and destruction of lymphoid follicles with infiltration of heterophils and presence of caseonecrotic debris in the bursal fold. H & E, × 140. Fig. 3. Metaplasia of bursal lining cells into stratified squamous epithelium with keratinization in a naturally infected bursa. H & E, × 540. Fig. 4. Degeneration of lymphoid cells, edema and infiltration of heterophils into lymphoid follicles of an experimentally infected bursa (7 days post-inoculation). H & E, × 312. Fig. 5. Replacement of lymphoid follicles with proliferation endodermal epithelial cells and formation of gland-like structure (15 days post-inoculation). H & E, × 312. Fig. 6. Presence of necrotic debris, desquamated epithelial cells and degenerated heterophils in bursal fold (7 days post-inoculation). H & E, × 312.

Inoculation of filtered and antibiotic-treated bursal suspension into 9-day-old embryonated chicken eggs showed less than 40% mortality, death occurring after 48 hours PI but commonly on 3rd and 4th day, occasionally upto 9th day PI with severe congestion. Subsequent embryo-passage materials proved to be non-infectious for 21-day-old chicks.

DISCUSSION

Gross and microscopic pathology of bursal lesions in natural and experimental cases of the infection were indistinguishable from those already reported for infectious bursal disease or Gumboro disease (Cosgrove, 1962; Helmboldt and Garner, 1964; Snedeker *et al.*, 1967; Benton *et al.*, 1967, Cheville, 1967). Cases with metaplastic changes into stratified squamous epithelium with formation of keratin, extensive fibroplasia and presence of a caseous necrotic core almost filling the bursa, which get reduced into a sac-like structure are not encountered in experimental cases. However, experimental cases were observed only for 22 days PI and duration of lesions in natural cases appear to be long-standing. Moreover, secondary infection in natural cases might also be a factor in producing such extensive bursal destruction as compared to experimentally-infected bursae which were culturally negative for bacteria. Some other concurrent factors such as Vitamin A deficiency (Winterfield *et al.*, 1962) and infection with Marek's disease (Jakowski *et al.*, 1969, 1970) might have a synergistic effect on the causation and severity of lesions by IBD in natural cases, whereas these factors are not associated in experimental infection.

The low embryonic mortality and the ability of embryo-passage materials to become avirulent for 21-day-old chicks might be the result of using embryos from the similar source where incidence of the disease was recorded. These embryos appear to have parental antibody which might have reduced or prevented the take in these embryos (Winterfield, 1969).

SUMMARY

Infectious bursal disease (IBD) was recorded during routine post-mortem examination of chicks. Clinical signs, gross pathologic and histopathologic changes in natural and experimental infection did not differ from those described in other countries.

ACKNOWLEDGMENT

The authors acknowledge with appreciation the encouragement and technical facilities provided by Dr. C. M. Singh, M.S., Ph.D., Director, Indian Veterinary Research Institute, Izatnagar, Bareilly, U.P. Technical assistance of Mr. Sartaj Bahadur is duly acknowledged.

1. Badiola, C., Oliver, F. and Parla, J., *Vet. Bull.*, 1969, Abst. No. 3926.
2. Barron., N. S., *Vet. Rec.*, **1966**, **78**, **624**.
3. Benton,. W. J., Cover, M. S. and Rosenberger, J. K., *Avian Dis.*, 1967, **11**, 430.
4. Bond, D. S., Edgar, S. A., Calderin, G. G. and Ramos, E. N., *Ibid.*, 1970, **14**, 404.
5. Cheville, N. F., *Am. J. Path.*, 1967, **51**, 527.
6. Cosgrove, A. S., *Avian Dis.*, 1962, **6**, 385.
7. Helmboldt, C. F. and Garner, E., *Ibid.*, 1964, **8**, 561.
8. Jakowsksi, R. M., Fredrickson, T. N., Luginbuhl, R. E. and Helmboldt, C. F., *Ibid.*, 1969, **13**, 215.
9. —, —, Chomiak, T. W. and Luginbuhl, R. E., *Ibid.*, 1970, **14**, 374.
10. Landgraf, H, Vielitz, E. and Kirsch, R., *Vet. Bull.*, 1967, **37**, Abst. No. 2293.
11. Lensing, H. H., *Ibid*, 1969, **39**, Abst. No. 12[illegible]
12. Maire, C., Renault, L, Alamagny, A, and de Dreuille, M., *Ibid*, 1969, **39**, Abst. No. 3927
13. Meroz, M., *Ibid.*, **1967**, **37**, Abst. No. 5303.
14. Snedeker, C., Whills, F. K, and Moulthrop, I. M., *Avian Dis.*, 1907f **11**, 519.
15. Winterfield, R. W., Hitchner, S. B., Appleton, G. S, and Cosgrove, A. S., *L. and M. News and Views*, L and M. Laboratories, Selbyville, Delawarem, 1962, **3**, 1.
16. — and —, *Am. J. Vet. Res.*, 1962, **97**, 1273.
17. —, *Avian Dis.*, 1969, **13**, 548.

SYMPOSIUM ON TROPICAL ECOLOGY

IN January 1971, the International Society for Tropical Ecology, International Association for Ecology and the Indian National Science Academy sponsored a Symposium on Tropical Ecology, emphasizing Organic Production, at New Delhi, India. Delegates from nine nations discussed the current state of production ecology in tropical regions. Since tropical ecosystems are of major importance in the ecology of the biosphere, yet are relatively poorly known, it is important that an integrated program be undertaken with the objective of developing tropical ecosystem models which could be used for management and land-use planning. Several large sets of data, accumulated from studies in Thailand, India, Ivory Coast, Congo, Panama, Costa Rica and Puerto Rico, could form the basis for modelling. The Symposium explored some of these and other data.

A working group was formed to provide integration of tropical ecology research and training. This group, consisting of K. C. Misra (India), F. Malaisse (Congo), E. Medina (Venezuela) and F. B. Golley (U.S.A.), will endeavour to produce a newsletter, an annual bibliography on tropical ecology and will organize a follow-up symposium at an appropriate place and time. Hopefully, the working group will be able to interact with all persons and groups interested in tropical ecology. To this end, tropical ecologists are invited to send items of interest for a newsletter to K. C. Misra (Department of Botany, Banaras Hindu University, Varanasi, India) and publications for an annual bibliography to F. Malaisse (University of Lubumbashi, Lubumbashi B.P. 1825 Conga-Kinshasa).

FRANK, B. GOLLEY, University of Georgia, U.S.A.)

LETTERS TO THE EDITOR

RESTRICTED RANDOM MATING: A NEW MATING MODEL

ESTIMATION of gene frequencies for any genetic character involves always directly or indirectly some assumptions about the structure of the population concerned (It may be noted, however, that for characters where all genotypes are phenotypically distinguishable, estimation of gene frequencies by gene count does not involve any assumption about the genetic structure of the population.) Furthermore, we know that construction of a model for studying the structure of a population again assumes the prevailing mating scheme in the population.[1] Kempthorne[2] has shown that repeated random mating leads to a population prescribed by Model I (Li and Horvitz[3]) and when a random mating population is inbred to an extent of F $(0 \leqslant F \leqslant 1)$, the resulting population behaves as a Model II (Wright's equilibrium population) one. Though these two are the most frequently studied population structures, their applicability is very often questioned.[4] Here, in this note, our main contention is to announce that one can proceed without any assumption regarding the mating structure at the phenotypic level and later use such a set-up to compute gene frequencies from a two-generation data.

To start with, let us consider two alleles 'A' and '*a*' at an autosomal locus. Let us also assume that 'A' is dominant over '*a*' so that only two phenotypes $\bar{A}$ (representing genotypes AA and A*a* collectively) and $\bar{a}$ (representing the genotype *aa*) are distinguishable. Thus, in this system, there are three phenotypic mating types. We designate the probabilities of the mating types $\bar{A} \times \bar{A}$, $\bar{A} \times \bar{a}$ and $\bar{a} \times \bar{a}$ by λ_1, λ_2 and λ_3 respectively $(0 \leqslant \lambda_i \leqslant 1,\ \lambda_1 + \lambda_2 + \lambda_3 = 1)$. Note that the attempt of writing these λ_i's as functions of p and q (the frequencies of the gene A and *a*, respectively) needs assumption about the mating structure. Instead, we define a parameter θ as the conditional probability that an individual is of genotype A*a* given that his phenotype is known to be $\bar{A}$.

With these parameters at hand and the general set-up at the phenotypic level, we make use of Hardy-Weinberg Law only at the level of dividing the general phenotypic mating frequencies into the corresponding genotypic frequencies. As for example, consider the mating type $\bar{A} \times \bar{A}$. This phenotypic mating can be split into the three corresponding genotypic matings in the proportions as shown in Table I.

TABLE I

Genotypic mating types given the phenotypic mating $\bar{A} \times \bar{A}$ and their probabilities

Genotype mating type	Probability
$Aa \times Aa$	θ^2
$Aa \times AA$	$2\theta(1-\theta)$
$AA \times AA$	$(1-\theta)^2$

With these it is easy to see that the segregation probabilities can be designated by Table II as follows (the N's and *n*'s are the corresponding observed frequencies in a random sample of N families).

TABLE II

Parental matings and the offspring phenotype probabilities

Parental matings		Offspring	
Type	Frequency	$\bar{A}$	$\bar{a}$
$\bar{A} \times \bar{A}$	$\lambda_1\ (N_1)$	$1-a^2\ (n_{11})$	$a^2\ (n_{12})$
$\bar{A} \times \bar{a}$	$\lambda_2\ (N_2)$	$1-a\ (n_{21})$	$a\ (n_{22})$
$\bar{a} \times \bar{a}$	$\lambda_3\ (N_3)$	0	$1\ (n_{32})$
Total	N		

where $a = \theta/2$.

Once this is done, the estimation is carried out by maximum likelihood method and it may be observed that the estimates of λ_i's are nothing but the observed relative frequencies (N_i/N) of the three phenotypic mating types. Estimate of θ depends upon the observations on the children only ($\hat{\theta} = 2\hat{a}$, where $\hat{a}$ is the positive root of $c_1 a^2 + c_2 a - c_3 = 0$; $c_1 = 2n_{11} + 2n_{12} + n_{21} + n_{22}$, $c_2 = n_{21}$ and $c_3 = 2n_{12} + n_{22}$) and they are asymptotically uncorrelated with the estimates of λ_i's. To test the goodness of fit statistic is evolved and its large sample distribution will be presented elsewhere.[5]

It is to be remembered that once the θ value is known for a population, the estimation of p and q can be carried out by means of gene counts, since the expected genotypic proportions will be known (*e.g.*, the relative frequency of A*a* genotypes $= \theta \times$ relative frequency of phenotype $\bar{\text{A}}$).

In this general analysis, it is to be noted that, the hypothesis of random mating is not dispensed with altogether. However, since in most cases there is no easy way of detecting an $\bar{\text{A}}$ individual as AA or A*a* (in case of blood groups, specially) any model which takes this point into account is going to be only of mathematical interest. So, the assumption of random mating in a restricted sense (at genotypic level only) as outlined above does not reduce the generality of the model.

Indian Statistical Inst., RANAJIT CHAKRABORTY.
203, B.T. Road,
Calcutta-35, *February* 9, 1971.

1. Chakraborty, R., Unpublished Ph.D. Thesis at Indian Statistical Institute, Calcutta, 1970.
2. Kempthorne, O., *Introduction to Genetic Statistics*, John Wiley and Sons, 1957 edition, Chapter II.
3. Li, C. C. and Horvitz, D. G., *Amer. J. Hum. Genet.*, 1953, **5**, 107.
4. Smith, C. A. B., Personal communication, 1970.
5. Adhikari, B. P., Sarma, Y. R. and Chakraborty, R., Unpublished, 1970.

THE SPECTRUM OF SrI IN THE PHOTOGRAPHIC INFRARED

THE spectrum of SrI as studied by earlier workers[1,2] consists of a number of well-developed bands degraded to longer wavelengths in the region λλ 4500-4200 Å. Mesnage[3] analysed these bands into two separate systems A and B. These bands were reinvestigated by Reddy *et al.* (1970)[4] under high dispersion (1·25 Å mm^{-1}) and were analysed and attributed to a doublet system designated as $C^2\Pi$-$X^2\Sigma$. In addition to this system, a few bands were reported by Walters and Barratt[2] in the near infrared. However, no analysis of these bands was reported so far.

The spectrum of SrI is reinvestigated in a radio frequency (40 MHz) discharged from a 500-watt oscillator through heated strontium metal in the presence of iodine and argon. In addition to the visible C-X system, the spectrum reveals the existence of a number of bands degraded to shorter wavelengths in the photographic infrared region λλ 7100-6500 Å. It is interesting to note that similar groups of bands were observed in the spectra of SrF, SrCl and SrBr molecules in the regions λλ 6675-5620 Å, λλ 6700-6230 Å and λλ 6925-6420 Å respectively. These groups of bands in each of these molecules were interpreted as belonging to two overlapping systems $A^2\Pi$-$X^2\Sigma$ and $B^2\Sigma$-$X^2\Sigma$. From the region of occurrence and the similarity of appearance of the groups of bands of SrI in the region λλ 7100-6500 Å, it is found possible to analyse them as belonging to two overlapping systems $A^2\Pi$-$X^2\Sigma$ and $B^2\Sigma$-$X^2\Sigma$.

From the similarity of their appearance, the two bands at $\nu = 14428\ \text{cm}^{-1}$ and $14752\ \text{cm}^{-1}$ could be easily identified as the two (0, 0) sub-bands of the $A^2\Pi$-$X^2\Sigma$ transition. The $\Delta G_{\frac{1}{2}}''(v)$ intervals of the two sub-systems (A_1-X and A_2-X) agree well with the $\Delta G_{\frac{1}{2}}(v)$ intervals of the ground state of the SrI molecule. The $\Delta G_{3/2}''(v)$ interval observed in the A_1-X sub-system agrees closely with the corresponding interval observed in the $C^2\Pi$-$X^2\Sigma$ system. These facts confirm the analysis and identification of A_1-X and A_2-X systems as two components of a $A^2\Pi$-$X^2\Sigma$ transition. The following approximate vibrational constants are derived for the $A^2\Pi$ state:

$$\nu_0 = \begin{matrix} 14420\ \text{cm}^{-1}\ \omega_e' = 190\cdot0\ \text{cm}^{-1}\ x_e'\omega_e' = 0\cdot5\ \text{cm}^{-1} \\ 14744\ \text{cm}^{-1}\ \omega_e'' = 174\cdot0\ \text{cm}^{-1}\ x_e''\omega_e'' = 0\cdot4\ \text{cm}^{-1}. \end{matrix}$$

In addition to the bands assigned to $A^2\Pi$-$X^2\Sigma$ system, the spectrum of SrI revealed a strong diffused band at $\nu = 14643\ \text{cm}^{-1}$ and two weak bands at $\nu = 14818\ \text{cm}^{-1}$ and $14992\ \text{cm}^{-1}$. The strong diffuse band is identified as the (0, 0) band and the weaker bands as the (1, 0) and (2, 0) bands of another system, designated as B-X. By analogy with the $B^2\Sigma$-$X^2\Sigma$ systems observed in each of the spectra of SrF, SrCl and SrBr, the B-X system of SrI is attributed to the transition $B^2\Sigma$-$X^2\Sigma$. Assuming the vibrational constants of the lower $X^2\Sigma$ state the following approximate vibrational constants of the upper $B^2\Sigma$ state are derived:

$$\nu_e = 14642\ \text{cm}^{-1},\ \omega_e' = 176\ \text{cm}^{-1}\ x_e'\omega_e' = 0\cdot5\ \text{cm}^{-1}.$$

The wave number, intensity and classification data of the band heads of both the systems are given in Table I. The vibrational constants of the A and B systems derived from the analysis are entirely in keeping with the $A^2\Pi$-$X^2\Sigma$ and $B^2\Sigma$-$X^2\Sigma$ systems of SrF, SrCl and SrBr molecules.

TABLE I

Band head data of the new $A^2\Pi$–$X^2\Sigma$ and $B^2\Sigma$–$X^2\Sigma$ systems of the SrI molecule

Wavenumber (cm⁻¹)	Assignment v', v''	Assignment System	$\nu_{obs.} - \nu_{cal.}$ (cm⁻¹)
14085	0, 2	A_1	+3·6
14256	0, 1	A_1	+0·2
14428	0, 0	A_1	0
14579	0, 1	A_2	+0·2
14597	1, 2	A_2	+1·4
14616	1, 0	A_1	−1·0
14643	0, 0	B	0
14752	0, 0	A_2	0
14769	1, 1	A_2	+1·2
14804	2, 0	A_1	−1·0
14818	1, 0 3, 1	B A_1	0 −0·8
14941	1, 0	A_2	0
14956	2, 1	A_2	+0·2
14992	2, 0	B	0
15129	2, 0	A_2	0
15143	3, 1	A_2	+0·2

Spectroscopy Res. Labs. B. R. K. REDDY.
Dept. of Physics, Y. P. REDDY.
Andhra University, C. G. RAMA RAO.
Waltair (A.P.), P. TIRUVENGANNA RAO.
December 18, 1970.

---

1. Olmsted, C. M., *Z. Wiss. Photogr.*, 1906, **4**, 255.
2. Walters, O. H and Barratt, S., *Proc. Roy. Soc.*, 1928, **118**, 120.
3. Mesnage, P., *Ann. de Phys.* (Paris), 1939, **12**, 5.
4. Reddy, B. R. K., Reddy, Y. P. and Rao, P. T., *J. Phys. B* (*Atom. Molec. Phys.*), Accepted for publication.

LEUCOPELARGONIDIN FROM *HYDNOCARPUS WIGHTIANA*

THE powdered pericarp of *H. wightiana* was defatted with petroleum ether and extracted completely with cold acetone. The acetone extract was concentrated to a thick syrup at low pressure and extracted with ether and then with ethyl acetate.

The ethyl acetate extract was dried and concentrated to a thick orange-red liquid under reduced pressure. Gradual addition of petroleum ether (40–60) removed the coloured impurities and then gave a light brown solid. This was redissolved in small quantity of dry ethyl acetate and fractionally precipitated with petroleum ether (40–60), followed by cooling, until a colourless powder (4·5 g) was obtained.[1] It did not melt till 300° C but darkened at 218–225° C with spurting. (Found : C, 54·7; H, 5·6 ; $C_{15}H_{14}O_6$ 2 H_2O requires C, 55·3 ; H, 5·4). It gave a bluish-green colour with ferric chloride and a pink colour with alcoholic hydrochloric acid which deepened on heating.

The compound was converted into anthocyanidin chloride as described for leucodelphinidin chloride.[1] The 1% hydrochloric acid solution gave the following : (*a*) a positive ferric reaction, (*b*) almost completely extracted with cyanidin reagent, (*c*) no change on air oxidation, (*d*) Rf. (circular, phenol-water lower layer) 0·83. The ethonolic hydrochloride solution had absorption maximum at 535 mμ.

The leucoanthocyanidin formed a colourless penta-acetate with acetic anhydride and pyridine in the cold. It softened at 161° C and melted at 168–169° C. (Found : C, 59·6, H, 5·1 ; $C_{25}H_{24}O_{11}$ requires C, 60 ; H, 4·8%.) The trimethyl ether of the leucoanthocyanidin was prepared using ethereal diazomethane ; crystallised from methanol and melted at 146–149° C. (Found : C, 65·1 ; H, 6·5 ; $C_{18}H_{20}O_6$ requires C, 65 ; H, 6·1%.) On acetylation, the methyl ether gave the diacetate, m.p. 180–183° C (Found : C, 63·3 ; H, 5·6 ; $C_{22}H_{24}O_8$ requires C, 63·4 ; H, 5·8%) and on oxidation with powdered potassium permanganate[1] gave an acid, m.p. 181–183° C, which was identified as anisic acid by m.m.p. and co-chromatogram with authentic sample.

From the above observations, the leucoanthocyanidin, isolated, has been identified as leucopelargonidin.

We wish to thank Prof. N. S. Wariyar for his guidance and encouragement.

Dept. of Chemistry, K. AIYYAPPAN NAIR.
Kerala University, N. RAMIAH.
Trivandrum-1, *December* 22, 1970.

---

1. Gangulay, A. K. and Seshadri, T. R., *Tetrahedron*, 1958, **3**, 225.

STRUCTURE OF $NO_2^{=}$

$NO_2^{=}$ with 19 valence electrons is isoelectronic with O_3^-, ClO_2 and SO_2^-. Following the arguments of Walsh,[1] we would expect the 19-electron AB_2 systems to be bent in the ground state with an apex angle between 110° and 120°. We have now carried out CNDO/2 calculations[2] on $NO_2^{=}$ and O_3^- to find the bond distances and angles in their electronic ground states. In addition, we have calculated the normal vibrations in $NO_2^{=}$ and compared the calculated and observed infrared frequencies.

In our CNDO/2 calculations, we have minimized the energy of the system with respect to the bond distance and the bond angle. In the case of NO_2^- we obtained a bond angle of 118·5° and an N-O distance of 1·23 Å ; the observed apex angle[3–5] in NO_2^- is 115·4°. The results of our calculations on $NO_2^=$ and O_3^- are listed along with the results of NO_2 and NO_2^- in Table I. We see that the calculated apex angle in $NO_2^=$ is larger than expected while the N-O distance is exactly what one would have expected.[5] The N-O bond order in $NO_2^=$ is considerably lower than in NO_2 or NO_2^- ; the negative charges on both N and O atoms increase in the series NO_2, NO_2^- and $NO_2^=$. In the case of O_3^-, the calculated bond distance is shorter than expected while the apex angle is higher.[5]

TABLE I

CNDO/2 calculations on AB_2 systems

Molecule		No. of valence electrons	Angle, deg.		re, Å		μ, D		Charges	
			Calc.	Obs.	Calc.	Obs.	Calc.	Obs	Central atom	End atom
NO_2	..	17	137·7	132·0	1·20	1·20	0·74	± ·4	+0·410	−0·205
NO_2^-	..	18	118·5	115·4	1·23	1·236	2·81	..	+0·088	−0·544
$NO_2^=$	..	19	123·0	..	1·30	..	4·26	..	−0·338	−0·831
O_3^-	..	19	118·5	..	1·20	..	3·20	..	+0·083	−0·541

We note here that there should be a decrease in the bond angle while going from an 18-electron AB_2 system to a 19-electron system although the magnitude of the decrease may be smaller than that associated with a change from a 16- to a 17-electron system.[1] Our calculated angles for both $NO_2^=$ and O_3^-, however, do not show this trend. It is possible that bond angles calculated for open shell systems like $NO_2^=$ and O_3^- are not reliable. In order to obtain more information regardng the structure of $NO_2^=$ we next examined its vibrational spectrum.

The infrared spectrum of freshly prepared Na_2NO_2 exhibits three bands at 1298, 1238 and 880 cm^{-1} which can be assigned to the $\nu_{asym}(NO_2)$, $\nu_{sym}(NO_2)$ and $\delta(ONO)$ modes respectively. These observed frequencies of $NO_2^=$ fall in line with the observed frequencies of NO_2 and NO_2^- (Table II). We calculated the vibrational modes of $NO_2^=$ in order to substantiate the assignments and to obtain some information on the structure. For this purpose we employed the Urey-Bradley-Shimanouchi Force Field.[7] We assumed the N-O distance of 1·30 Å and a reasonable ONO angle[5] of 110° and fixed the N-O stretching force constant, $K_{(NO)}$, by making use of the plot of $K_{(NO)}$ of NO_2, NO_2^-, NO ($B^2\Delta$) and NO ($B^2\pi$) against the N-O bond distance.[8] We applied a 3% correction for anharmonicity for all these force constants.[9] The $K_{(NO)}$ thus obtained for $NO_2^=$ was 6·40 m dynes/Å. We iterated the bending and 1-3 interaction force constants[10] and could obtain a good fit for the observed frequencies when $H_{(ONO)} = 0·45$ and F(O- - -O) 1·85 m dynes/Å, etc. We could not obtain any reasonable fit of frequencies with a $K_{(NO)}$ of 6·40 when the bond angle was 120°. It appears that a bond angle of 110° and an N-O distance of 1·30 Å appropriate for $NO_2^=$.

TABLE II

Fundamental frequencies of NO_2, NO_2^- and $NO_2^=$

		ν_{asym} (NO_2) cm^{-1}	ν_{sym} (NO_2) cm^{-1}	δ (ONO) cm^{-1}	Ref.
NO_2 (obs.)	..	1618	1320	750	6
NO_2^- (obs.)	..	1328	1261	828	4
$NO_2^=$ (obs.)	..	1298	1238	880	Present study
$NO_2^=$ (calc.)	..	1299	1214	880	,,

The authors are thankful to Professor C. N. R. Rao for valuable discussion and guidance.

Dept. of Chemistry,
Indian Inst. of Tech.,
I.I.T. P.O., Kanpur-16,
February 3, 1971.

H. S. RANDHAWA.
K. C. PATIL.

---

1. Walsh, A. D., *J. Chem. Soc.*, 1953, p. 2266.
2. Pople, J. A. and Segal, G. A., *J. Chem. Phys.*, 1966, **44**, 3289.
3. Carpenter, G B., *Acta Chryst.*, 1952, **5**, 132.
4. Weston, R. E. Jr. and Brodasky, T. F., *J. Chem. Phys.*, 1957, **27**, 683.
5. Smitb, P., *J. Phys. Chem.*, 1956, **60**, 1471.
6. Arakawa, E. and Nielsen, H., *J. Mol. Spec.*, 1938, **2**, 413.
7. Shimanouchi, T, *J. Chem. Phys.*, 1955, **25**, 35, *Ibid.*, 1949, **17**, 245, 754, 848.
8. Smith, S. and Linnett, J. W., *Trans. Faraday Soc.*, 1956, **52**, 891.
9. Lippincott, E. R, and Schroeder, R., *J. Am. Chem. Soc.*, 1956, **78**, 5171
10. Patil, K. C., Gosavi, R. K. and Rao, C. N. R., *Inorg. Chim. Acta*, 1967, **1**, 155.

BIS-ANILINIUM HEXAHALO ZIRCONATES OR HAFNATES (IV)

Bis-pyridinium hexachloro zirconate and hafnate have been reported before.[1,2] These compounds have been used to prepare zirconium or hafnium tetra alkoxides. We wish to report now the preparation of anilinium hexachloro zirconate and hafnate as well as their conversion to the analogous hexabromo and hexaiodo zirconates and hafnates.

PREPARATION

Bis-*Anilium Hexachloro Zirconate or Hafnate (IV) Method* I.—Zirconium tetrachloride or hafnium tetrachloride was dissolved in absolute methanol and saturated with dry hydrogen chloride gas. Then the calculated weight of AnalaR aniline (mole ratio of tetrachloride to aniline = 1 : 2) was added and stirred. Once again the solution was saturated with dry hydrogen chloride gas. Later the methanol was gently removed at room temperature at the pump, until the volume was reduced to nearly a third. Crystallisation was then induced by placing in the ice-box. The crystals were filtered off, washed with *ether* and dried in the vacuum desiccator to remove any absorbed hydrogen chloride.

Method II.—Aniline hydrochloride was freshly prepared, recrystallised from ethanol and dried. This was added to zirconium or hafnium tetrachloride in thionyl chloride, in the mole ratio of 2 : 1 and stirred for two hours, out of contact with moisture. The precipitate formed was filtered off, washed with a few drops of acetic anhydride and then with ether, before drying in the vacuum desiccator.

The product, obtained by both methods as colourless needle-shaped crystals, was insoluble in ether, chloroform, etc., but dissolved with decomposition in water. Analytical results of the products obtained by both methods were similar. The values are given in Table I.

Bis-*Anilinium Hexabromo Zirconate or Hafnate (IV)*.—Finely-powdered anilinium hexachloro zirconate or hafnate was stirred into excess anhydrous hydrobromic acid (mole ratio 1 : 6). The stirring was continued for two hours and then the reaction mixture was concentrated *in vacuo* at room temperature. After inducing good crystallisation in the ice-box, the crystals were filtered off, washed well with AnalaR benzene and ether and then dried satisfactorily in the vacuum desiccator.

The needle-shaped crystals had a brown colour and were insoluble in common organic solvents except alcohols. They dissolved readily with decomposition in water. Analytical results are given in Table I.

Bis-*Anilinium Hexaodo Zirconate or Hafnium (IV)*.—These two compounds also were prepared from *bis*-anilinium hexachloro zirconate and hafnate respectively, by adding the latter to anhydrous hydriodic acid in the mole ratio of 1 : 6 and using the procedure outlined in the previous section.

The pale red crystals showed properties similar to those of the hexachloro or hexabromo zirconate and halfnate described above. The analytical results are included in Table I.

Effect of Heat on Bis-*Anilinium Hexachloro Zirconate or Hafnate*.—When bis-anilinium hexachloro zirconate or hafnate was heated in a current of dry hydrogen chloride, in a pyrex glass combustion tube, decomposition of the compound was observed and white fumes were swept out. But when the temperature was slowly raised to 390° C or above, a white sublimate deposited in the cooler parts of the tube and was identified by tests and analytical results as zirconium or hafnium tetrachloride. Hence, the anilinium hexachloro zirconate or hafnate underwent decomposition on heating and pure zirconium or halfnium tetrachloride was one of the products that could be recovered.

TABLE I

Compound	Found			Required for $(AnH)_2MX_6$*		
	Zr or Cl, Br		Aniline	Zr or Cl, Br		Aniline
	Hf	or I		Hf	or I	
$(AnH)_2ZrCl_6$ ..	18·5	42·9	37·9	18·4	43·1	38·2
$(AnH)_2HfCl_6$.	30·6	36·5	32·1	30·8	36·7	32·4
$(AnH)_2ZrBr_6$ ..	12·0	62·9	24·3	12·0	63·2	24·7
$(AnH)_2HfBr_6$ ..	21·0	56·0	21·9	21·1	56·7	22·2
$(AnH)_2ZrI_6$ ..	8·6	73·0	18·0	8·8	73·2	18·1
$(AnH)_2HfI_6$ ..	15·5	67·2	16·5	15·8	67·5	16·7

* AnH = anilinium; X = Cl, Br or I.

Dept. of Chemistry, K. BABUKUTTY.
University of Kerala, P. T. JOSEPH.
Trivandrum, January 8, 1971.

---

1. Bradley, D. C., Abd-El Halim, F. M., Sadek, E. A. and Wardlaw, W., *J. Chem. Soc.*, 1952, 2032.
2. Clark, R. H. J, and Errington, W., *J. Chem. Soc.*, *A*, 1967, 258.

IDENTIFICATION OF CHLORAL HYDRATE FROM BIOLOGICAL MATERIALS IN THE PRESENCE OF FORMALDEHYDE BY TLC

CHLORAL hydrate is a poison commonly encountered in poisoning cases and visceral material despatched to this laboratory in connection with above suspected poisoning cases often erroneously preserved in formalin. The extraction of poison from such biological materials also carries formaldehyde with it. The usual chemical tests fail to distinguish unambiguously between chloral hydrate and formaldehyde and the mixed extract when developed on thin layer chromatogram (TLC) and sprayed with Nessler's Reagent (NSR) gives inconclusive results for chloral hydrate, as the R_f values of the two are almost similar.

In the present communication, a process has been described using two new reagents, *viz*., (*a*) thiobarbituric acid (TBA) followed by Nessler's Reagent, and (*b*) 1-phenyl-3-methyl-5-pyrazolone (1, 3, 5-PMP) for the detection of chloral hydrate and formaldehyde when present together.

Fiegl and Libergott[1] have reported a spot test for α, β-unsaturated and aromatic aldehydes with TBA giving coloured adducts. Nisbet[2] applied this test for the identification of polyhydride alcohols on TLC after oxidizing them with acidified dichromate solution. The condensation of TBA and such aldehydes results in giving a strong conjugation in the reaction product which subsequently imparts colouration (Fig. 1). We found that chloral hydrate, though not having such α, β-unsaturation, also forms pink-coloured compound with TBA (Fig. 2).

Acetaldehyde and formaldehyde were also treated with TBA under identical conditions. It was observed that acetaldehyde gave a yellow-coloured compound whereas formaldehyde gave colourless. From these observations, it can be concluded that formation of a pink-coloured compound in the condensation of chloral hydrate with TBA is due to the presence of three bulky chlorine atoms.

Since formaldehyde did not form any coloured compound with TBA, it was thought worthwhile to use this reagent for identification of chloral hydrate in the presence of formaldehyde from biological material.

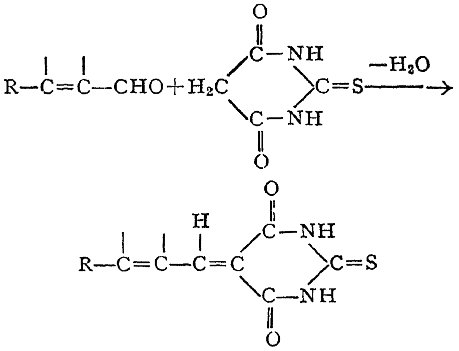


FIG. 1

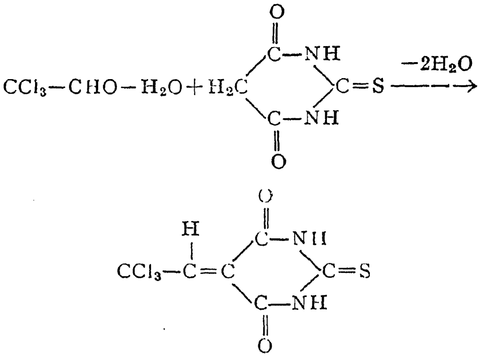


FIG. 2

A mixed spot of chloral hydrate and formaldehyde extract obtained from the visceral material was developed on TLC plate. It was sprayed, first with TBA and after 10 minutes with Nessler's Reagent. A black spot corresponding to formaldehyde appeared immediately, whereas a pink spot corresponding to chloral hydrate developed after keeping the plate in an oven for 5-10 minutes. The method when repeated with authentic mixture of chloral hydrate and formaldehyde gave identical results.

It was also observed that chloral hydrate gives deep brown compound when treated with 1, 3, 5-PMP. When a mixed spot of chloral hydrate and formaldehyde extract developed on TLC plate and then sprayed with 1, 3, 5-PMP only, a deep brown spot due to chloral hydrate appeared immediately. After heating the plate in oven, a bright white spot corresponding to formaldehyde appeared on the light brown background.

METHOD

Reagents

(*i*) *Thiobarbituric Acid Solution.*—Dissolve 2·12 g of anhydrous sodium carbonate in 100 ml distilled water and add 2·88 g of 2-thiobarbituric acid in this solution.

(*ii*) *Nessler's Reagent* (*NS*).—Add 80 ml of potassium iodide solution (5%) to 25 ml of saturated solution of mercuric chloride. The mixture is made alkaline by adding 25 ml of sodium hydroxide solution (20%).

(*iii*) Standard chloral hydrate solution in water (5%).

(*iv*) Standard formaldehyde (40%) formalin.

(*v*) 1-*phenyl*-3-*methyl*-5-*pyrazolone Reagent* (1, 3, 5-*PMP*).—Dissolve 2·12 g of anhydrous sodium carbonate in 100 ml distilled water and add 3·48 g of 1, 3, 5-PMP in this solution. This reagent should be fresh every time.

(*vi*) *TLC Plate.*—The plates were coated with 700 μm layer of silica gel G and activated by heating at 110° C for half hour.

(*vii*) *n*-Propanol (BDH GLC grade).

(*viii*) Petroleum ether (b.p. 60-80° C) BDH.

PROCEDURE

(*i*) *Detection with TBA and Nessler's Reagent.*—TLC plate was spotted with visceral extracts and developed in the solvent system petroleum ether : *n*-propanol in the proportion 7 : 3. The chromatogram, after drying at room temperature, was sprayed with TBA and then with Nessler's Reagent. A black spot due to formaldehyde appeared immediately (R_f = 0·58). The plate was then heated in oven at 80° to 90° C for 5-10 minutes. A pink-coloured spot corresponding to chloral hydrate appeared at R_f = 0·95.

The spots of visceral extracts, thus appeared, were comparable with those of authentic mixture of chloral hydrate and formaldehyde.

(*ii*) *Detection with 1, 3, 5-PMP.*—The TLC plate was spotted with visceral extracts and developed in the solvent system petroleum ether : *n*-propanol 7 : 3. The chromatogram after drying at room temperature was sprayed with 1, 3, 5-PMP reagent. A deep brown spot corresponding to chloral hydrate (R_f = 0·95) appeared. The plate was further heated in oven at 80°-90° C for about half-an-hour. A bright white spot on light brown background was located (R_f = 0·58). The spots were comparable with those obtained with an authentic mixture of chloral hydrate and formaldehyde.

The minimum limit of detection observed for chloral hydrate in formaldehyde by these methods was 0·05 mg.

Forensic Science Lab.,
State of Maharashtra,
Byculla, Bombay-8,
India, *February* 5, 1971.

S. S. KAMAT.
V. P. BARVE.
H. S. MAHAL.

---

1. Fiegl, F. and Libergoth, E., *Analyt. Chem.*, 1964, **36**, 132.
2. Nisbet, M. A., *Analyst*, 1969, **94**, 811.

SUCCINYLCHOLINE AND SYNAPTIC TRANSMISSION IN THE CEREBRAL CORTEX

CENTRAL action of neuromuscular blocking drugs have been studied by several group of workers.[1,2,4,6] Succinylcholine, a neuromuscular blocking drug, is used extensively in neurosurgery and in experimental preparations to prevent reflex movement. Use of this drug in studies of the central nervous system presupposes that it has no effect on the neural element. However, Mountcastle *et al.*[7] have warned that neuromuscular blocking drugs may depress central synaptic transmission. Recently, a number of reports have appeared showing the action of gallamine on central synaptic transmission, however, the results are conflicting.[4,5,7] Since these drugs are so widely used both in clinical and experimental procedures, and there are so many conflicting reports regarding their action on the central nervous system, the experiments were designed to study the effect of succinylcholine (after topical application) on the cortical synaptic transmission with a view to establish if it has any direct action on the central nervous system.

In rats (CFE strain from Carworth, Europe) lightly anaesthetised with pentobarbitone, the technique of Bhargava and Meldrum[1] was employed to record the averaged somatosensory-evoked potentials. Computer derived averages of 32 consecutive somatosensory-evoked potentials from both cortices, in response to the stimulation of the contralateral and ipsilateral forepaws were recorded. Succinylcholine dissolved in artificial CSF was applied to the pial surface through specially designed cortical cups. In most of the experiments, the drug was applied to one cortex while the other cortex was bathed with normal CSF and served as control throughout the experiment.

A continuous record of spontaneous electrocortical (EEG) activity and cortical and rectal temperatures was obtained on the different channels of a polygraph (Devices).

After control records were made, succinylcholine was applied in different concentrations (10^{-4} M, 3×10^{-4} M, 10^{-3} M and 5×10^{-3} M) to the cortex for a period of 15 to 30 minutes, and its effect on the somatosensory-evoked potentials was observed. With each concentration, at least 4 to 6 experiments were performed.

In all experiments, succinylcholine in various concentrations did not produce any effect on the positive or the negative waves of the primary cortical-evoked potentials nor did it modify the repetitive after discharges.

In the control cortex, succinylcholine did not produce any effect on the cortical-evoked potentials following stimulation of the contralateral or the ipsilateral forepaws.

Until recently, succinylcholine, gallamine and other related drugs were thought to be relatively free of central effects. However, in the recent years a number of reports have appeared showing an effect on the central nervous system. It has been proposed that due considerations should be given in interpretation of the data with this agent, and its use in humans predisposed to convulsive disorders should be revalued.[5] de Jong *et al.*[3] have shown that at least in the spinal cord the effect of gallamine is secondary to a rise in the blood pressure and as such it does not influence synaptic transmission. In the present experiments the systemic effects of succinylcholine were excluded by its cortical application. Because cortical, and rectal temperatures and depth of anaesthesia were well controlled, it seems unlikely that these factors affected the action of succinylcholine. Moreover, the influence of the systemic effect of drug (*e.g.*, application of noradrenaline to the cortex can modify blood pressure[8]) and the remote effect of drug following systemic absorption were well controlled by recording from the opposite (non-drug-treated) cortex, throughout the experiment. This also monitored the physiological state of the animal.

In the present study, succinylcholine failed to produce any effect on the somatosensory-evoked potentials. It appears that succinylcholine has essentially no effect on the impulse transmission in the cerebral cortex and thus can be safely employed in neuro-surgical operations and in experimental studies of the central nervous system.

The author (V. K. B.) wishes to express his gratefulness to Dr. B. S. Meldrum for his guidance and to the Wellcome Trust for a Fellowship.

Medical Res. Council, V. K. BHARGAVA.*
Neuro-psychiatry Unit, P. BHARGAVA.
Carshalton, U.K., *December* 21, 1970.

---

* Present address: Department of Pharmacology, Maulana Azad Medical College, New Delhi.

1. Bhargava, V and Meldrum, B. S., *Brit. J. Pharmacol.*, 1969. **37**, 112
2. Chang, H. T. J., *Neurophysiol.*, 1953, **16**, 221.
3. de Jong H. R., Robles, R. and Morikawa, K. I., *Science*, 1968, **163**, 768
4. Halpern, L. M and Black R. G., *Ibid.*, 1967, **155**, 1685.
5. — and —, *J. Pharm. Exp. Therap*, 1968, **162**, 166.
6. Longo, V. C., *Experientia*, 1955, **11**, 76.
7. Mountcastle, V. B., Davies, P. W. and Berman, A. L., *Neurophysiol.*, 1957 **20**, 374.
8. Walaszek, E. J., *Int. Rev. Neur. biol.*, 1960, **2**, 137,

THE EFFECT OF PRENYLAMINE (SEGONTIN) ON SMOOTH MUSCLES

PRENYLAMINE, [N(3'phenyl-propyl-(2')]-1, 1-diphenyl-propyl-(3)-amine (segontin) is a new coronary vasodilator. With large doses, prenylamine leads to adrenergic and ganglionic blockade with a fall in blood pressure and sedation.[8] The drug brings about a release of both norepinephrine and serotonin from tissues, mainly from brain and heart.[1-5] This action of prenylamine has been thought to be similar to that of reserpine.[6] Recently, Ganguly[7] studied the effect of reserpine on smooth muscles and reported that reserpine, in addition to its anticholinergic action, also possesses direct relaxant property. Considering the probability that prenylamine possesses the same mode of action as reserpine, it was thought worthwhile to study the effect of prenylamine on smooth muscles against different spasmogens and to ascertain the probable mechanism of action.

In the present study, the investigations were carried out on (*a*) isolated guinea-pig ileum, (*b*) isolated rabbit duodenum, and (*c*) isolated rat uterus. Tyrode's solution was used for (*a*) and (*b*), and Dejalon's for (*c*). The temperature of the bath was maintained at 37° C for all experiments. However, those with the rat uterus were carried out at 31° C. The capacity of the bath was 10 ml.

Prenylamine showed a dose-dependent, reversible inhibitory effect on acetylcholine-induced contractions on rabbit duodenum, histamine-induced contractions on guinea-pig ileum and serotonin-induced contractions on rat uterus. The dose response curves for the different agonists recorded in the presence of various concentrations of prenylamine (8×10^{-8} M to 32×10^{-8} M for histamine; 4×10^{-8} M to 16×10^{-8} M for acetylcholine and 3×10^{-6} M to 12×10^{-6} M for serotonin) showed a progressive flattening and the maximum response was reduced in all the experiments.

Prenylamine in the concentration of 10-20 µg/ml also manifested an inhibitory effect on the barium chloride-induced contractions of guinea-pig ileum.

From the present observations it appears that the smooth muscle relaxant property of prenylamine may be due to a non-specific effect on the tissues.

Medical College, A. P. Saraf.
Aurangabad; and
S.S. Medical College, C. B. Seth.
Rewa, *January* 12, 1971.

---

1. Oblanwa, H. O., *Acta Pharmacol. Toxicol.*, 1965, **25** (1), 141.
2. Carlson, *et. al.*, *Acta Physiol. Scand.*, 1969, **59**, (Suppl.) 215.
3. Grief. S., *Wiener. Medisinische. Wochenschrift*, 1966, **116**, 965.
4. Carlson *et al.*, *Acta Physiol. Scand.*, 1963, **56**, 220
5. Werdinius, B., *Acta Pharmacol. Taxicol.*, 1967, **25** (1), 1.
6. Fossion, A. C., *et. al.*, *Arch, Int. Pharm. Therap.*, 1967, **167** (1), 142.
7. Ganguly, D. K., *Ind. J. Physiol. and Pharm.*, 1969, **13**, 81.
8. Drill, *Drill's Pharmacology in Medicine*, 1965, 3rd edition, p. 616.

PREGNANE DERIVATIVES OF *MARSDENIA VOLUBILIS* T. COOK.

In our earlier communications[1,2] we have reported the isolation of terpenes, sterols and flavonoids from *Marsdenia volubilis* (Syn.: *Dregea volubilis*). In view of the reported isolation of a glycoside, dregoside A (cyamaroside of drevogenin A) by Mitsuhashi *et al.*[3] from the dried stems of this plant, we record here the results of the examination of the pregnane glycoside fraction of both the stems and leaves and bark.

The powdered material (stems and leaves and bark examined separately) was successively extracted with petroleum ether, chloroform and alcohol. The chloroform extract on concentration left a dark green amorphous residue in each case. It showed positive Keller-Kiliani reaction for the presence of 2-deoxy sugars and negative Legal and Kedde reactions (absence of cardenolides). The residue in each case was subjected to chromatography over alumina and the results were similar. All the glycosidic fractions were amorphous. Fractions showing steady positive Keller-Kiliani reaction were combined and subjected to mild acid hydrolysis.[4] The aglycone fraction showed in T.L.C. four spots and could not be crystallized even after chromatography. The sugar fraction was found to consist of both aglycones and sugars. It was subjected to chromatography over silica gel whereby four crystalline substances (A, B, C and D) were obtained in that order from both stems and leaves and bark.

Substance A was obtained as colourless prisms from ether-petroleum ether, m.p. 183-86°; $[\alpha]_D = +47 \cdot 6°$ (methanol). It showed negative Keller-Kiliani reaction, but gave positive tetranitromethane test and analysed for the formula $C_{28}H_{42}O_7$. It formed isodrevogenin P (*see* under substance D) with 5% KOH in 90% methanol, m.p. 164-70°/178-80°. These properties led to the conclusion that substance A is identical with drevogenin A[5].

Substance B crystallized from ether as colourless short needles, m.p 88-93°; $[\alpha]_D^* = +50 \cdot 5°$ (water). It showed deep blue colour in Keller-Kiliani reaction and analysed for the formula $C_7H_{14}O_4$ with one methoxyl. These properties indicated that it could be identical with D-cymarose. This was confirmed by direct comparison with an authentic sample (mixed m.p. T.L.C. and paper chromatography).

Substance C crystallized as colourless needles from ether, m.p. 65-67°, $[\alpha]_D^* = +11 \cdot 2°$ (water). It also showed blue colour in Keller-Kiliani reaction and analysed for the formula $C_7H_{14}O_4$ with one methoxyl. From these properties it was identified as L-oleandrose.

Substance D crystallized as colourless needles from methanol-ether, m.p. 126-30°/210-14°, $[\alpha]_D = +35 \cdot 2°$ (chloroform). From acetone colourless prisms were obtained, m.p. 190°/208°/214-20°. It showed positive TNM reaction and negative Keller-Kiliani reaction. It analysed for the formula $C_{21}H_{32}O_5$ and gave an isocompound, m.p. 163-65°/175-78; $[\alpha]_D = -51 \cdot 2°$ (methanol). Substance D formed a di-O-acetyl derivative (pyridine-acetic anhydride; room temperature), $C_{25}H_{36}O_7$, m.p. 110-20°/175-80°; $[\alpha]_D = +47 \cdot 5°$ (chloroform) and a tri-O-acetyl derivative, $C_{27}H_{38}O_8$ (pyridine-acetic anhydride at 100°), m.p. 170-75°; $[\alpha]_D = +52 \cdot 3°$ (chloroform). From these properties, substance D was inferred to be drevogenin P[5].

The authors are grateful to Prof. T. Reichstein, University of Basel, Switzerland, for the gift of a reference sample of *D*-cymarose and Dr. N. Viswanadham for encouragement.

Dept. of Pharmacy, Andhra University, Waltair, *January* 11, 1971.

D. Venkata Rao.
E. Venkata Rao.

---

* Equilibrium value.

1. Venkata Rao, D., Venkata Rao, E. and Viswanadham, N., *Curr. Sci.*, 1967, **36**, 421.
2. — and —, *Phytochem.*, 1969, **8**, 1609.
3. Hayashi, K., Nakao, A. and Mitsuhashi, H., *Chem. Pharm. Bull.*, 1969, **17**, 2629.
4. Rangaswami, S. and Reichstein, T., *Helv. Chim. Acta*, 1949, **32**, 939.
5. Sauer, H. H., Weiss, Ek. and Reichstein, T., *Ibid.*, 1965, **48**, 857.

FLAVONOIDS OF *MILLINGTONIA HORTENSIS*

Not much work has been recorded on the flavonoids of *Bignoniaceae*, a family of some 100 genera and 650 species. Harborne[1] has recorded the flavonoid distribution in about 15 plants and Sharma *et al.*[2] recently reported the isolation of scutellarein and its 5-galactoside from the flowers of *Millingtonia hortensis* Linn. (Syn.: *Bigonia suberosa* Roxb.).[3-4] We have now systematically examined in detail the leaves and fruits as well as reinvestigated the flowers of this ornamental tree.[5]

Leaves.—Fresh leaves of *M. hortensis* were extracted with 80% methanol under reflux, and the aqueous concentrate, after the removal of all the organic solvents *in vacuo*, was fractionally extracted with petroleum ether and ether. The residue from the ether extract, on crystallisation from methanol, yielded a mixture of two flavones which were separated by fractional crystallisation of their acetates using ethyl acetate and petroleum ether; the more soluble fraction yielded colourless plates, m.p. 168-69° (MeOH) and the less soluble came out as colourless needles, m.p. 236-38°. On deacetylation (MeOH-HCl), the first compound gave a flavone, yellow needles, m.p. 283-85° (yield, 2%), $C_{16}H_{12}O_6$ (one methoxyl); $\lambda_{max.}$ (EtOH) 276 and 338 nm with a bathochromic shift of 15 nm with $AlCl_3$ and practically no change with NaOAc; IR (KBr) bands at 3400 (broad), 2920, 1650, 1580, 1490, 1360, 1250, 1175, 1090; 910 and 820 cm^{-1}. On methylation ($Me_2SO_4 + K_2CO_3$), it gave a tetramethylether, m.p. 162-63°. From the above data, it was identified as 6-methoxy-5, 7, 4′-trihydroxyflavone (hispidulin[6] = dinatin[7]), and the identity was confirmed by comparison with an authentic sample of hispidulin. Further, the triacetate of our pigment was directly compared with hispidulin triacetate by m.m.p., UV, IR, NMR and TLC through the kind help of Dr. W. Herz. The flavone from the less soluble acetate did not melt below 310°. From its colour reactions and R_f and preparing its tetramethylether, it was identified to be scutellarein, 5, 6, 7, 4′-tetrahydroxyflavone, which was confirmed by direct comparison with an authentic sample.

Fruits.—The pulp of the fresh pods separated from the rind was extracted with hot MeOH and the concentrate fractionated; the major flavone from the ether fraction was found to be hispidulin.

The outer rind of the fresh pods on extraction with hot 95% ethanol and concentration yielded a pale yellow solid, which when chromatographed on alumina yielded, from the chloroform eluate, colourless needles, m.p. 256-58°, $[\alpha]_D^{30}$ + 74°. It answered tests for a triterpenoid and was identified as acetyl oleanolic acid by getting oleanolic acid, m.p. 306-08° and direct comparison with an authentic sample of the compound.[8]

Flowers.—The fresh flowers on complete extraction with hot methanol and fractionation yielded (*a*) from the ether fraction scutellarein as the major and hispidulin as the minor component, and (*b*) from the ethyl acetate fraction, on crystallisation from glacial acetic acid, yellow needles not melting below 300° (earlier sintering about 240°), $[\alpha]_D^{30}$ − 138 (pyridine); $\lambda_{max.}$ (EtOH) 286, 338 giving a bathochromic shift of 15 nm with $AlCl_3$ and practically no shift with NaOAc; IR (KBr) bands at 3400 (broad), 2920, 1740, 1660, 1610, 1580, 1500, 1470, 1360, 1040, 905, 840 and 820 cm^{-1}. It could not be hydrolysed with 7% sulphuric acid in aqueous alcoholic medium, but on treatment with 10% sulphuric acid in acetic acid medium for 5 hours,[9] it gave a flavone, identified as scutellarein (by its colour reactions, R_f values, preparation of the acetate) and glucuronic acid. From the above data, it was identified as scutellarein.[9,10] More of the glucuronide[9] was obtained by treating the aqueous solution (after ethyl acetate) with $1N.H_2SO_4$ and keeping on a boiling water-bath for 20 minutes. We could not isolate scutellarein-5-galactoside as reported by Sharma *et al.*[2]

We are grateful to Prof. Werner Herz, Florida State University, for an authentic sample of hispidulin and direct comparison of our sample of the acetate with hispidulin triacetate, and Prof. T. R. Govindachari, Director, CIBA Research Centre, Bombay, for the spectral data, and Dr. A. Zaman, Aligarh Muslim University, for an authentic sample of scutellarein.

Dept. of Chemistry, S. SANKARA SUBRAMANIAN.
JIPMER, S. NAGARAJAN.
Pondicherry-6, (MRS.) N. SULOCHANA.
January 15, 1971.

1. Harborne, J. B., *Phytochem.*, 1967, **6**, 1643.
2. Sharma, R. C., Zaman, A. and Kidwai, A. R., *Ibid.*, 1968, **7**, 1891.
3. Gamble, J. S., *Flora of the Presidency of Madras*, Botanical Survey of India, Calcutta, 1957, **2**, 699.
4. *The Wealth of India: Raw Materials*, Council of Scientific and Industrial Research, New Delhi, 1962, **6**, 380.
5. Blatter, E. aud Millard, W. S., *Some Beautiful Indian Trees*, The Bombay Natural History Society, Bombay, 1954, p. 106.
6. Herz W. and Sumi, Y., *J. Org. Chem.*, 1964, **29**, 3438.
7. Bharadwaj, D. K., Neelakantan, S and Seshadri, T. R., *Indian J. Chem.*, 1966, **4**, 173.
8. Nair, A. G. R. and Subramanian, S. S., *J. Sci. and Ind. Res.*, 1962, **21B**, 457
9. Marsh, C. A., *Biochem. J.*, 1955, **59**, 58.
10. Hattori, S., In *the Chemistry of Flavonoid Compounds*. Ed. Geissman, T. A., Pergamon Press, 1962, p. 326.

LEPTOPHARYNX CHLOROPHAGUS SP. NOV. (CILIATA: PROTOZOA) FROM FRESHWATER OF WEST BENGAL, INDIA

WHILE examining a water sample from a freshwater pond of Kamarkundu, West Bengal, the author came across several specimens of the genus *Leptopharynx* Mermod which seem to belong to a new species. These specimens are bottom-dwelling sapropelic forms found amidst the bottom ooze of the sample in association with *Microthorax pusillus* Engelmann, *Cinetochilum margaritaceum* Perty and *Leptopharynx torpens* (Kahl).

Leptopharynx chlorophagus SP. NOV.
(Fig. 1)

Description.—Small, ovoid, right margin convex, left margin straight. Anterior end goes slightly beyond the left margin forming a short beak; posterior end broadly round. Length 23·1-27 μ (25 μ)[*]; breadth 13·2-16·5 μ (14·5 μ). Cytostome towards the left edge, just below the beak; pharyngeal basket absent. Macronucleus round or slightly ovoid, located below the middle of the body, measuring 4·5-5 μ (4·6 μ) by 3·8-4·5 μ (4·3 μ); micronucleus single, very small (1 μ diameter), round, placed adjacent to the posterior left of the macronucleus. Two contractile vacuoles—one little below the middle, the other near the posterior fifth of the body. Ciliation sparse throughout but little dense, though discontinuous, on the ridges. Trichocysts present. Cytoplasm heavily laden with green ingested food material which are found to be very characteristic of these forms.

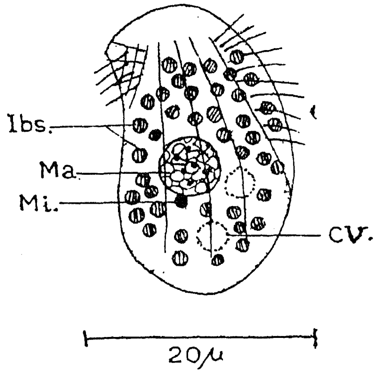


FIG. 1. *Leptopharynx chlorophagus* n. sp., dorsal view. (*Cv.*—Contractile vacuole; *Ibs*—Ingested bodies; *Ma*—Macronucleus; *Mi.*—Micronucleus.)

Type: 11 specimens on four slides will be deposited in the Zoological Survey of India.

Type Locality: Freshwater pond in Kamarkundu (Dist. Hoogly), West Bengal.

Date of Collection: 3-9-1968; Collector: A. K. Das.

Discussion.—Among the seven species of the genus *Leptopharynx* Mermod, *viz.*, *L. costatus* Mermod, *L. sphagnetorum* (Levander), *L. opaca* (Penard), *L. euglenivora* Kahl, *L. torpens* (Kahl), *L. eurystoma* (Kahl) and *L. agilis* (Savoie) described so far, the present species resembles *L. opaca* (Penard) and *L. torpens* (Kahl) in the absence of pharyngeal basket and is more akin to the former in the nature of ciliation. But its smaller size (25 μ × 14·5 μ) in contrast to 40-50 μ length of *L. opaca* (Penard) and 60 μ length of *L. torpens* (Kahl) and cytoplasm with characteristic haematoxynophilic-ingested bodies easily differentiate it from those species. *L. opaca* (Penard) further differs from the present species in possessing usually a single contractile vacuole located below the middle of the body. *L. torpens* (Kahl) has spines at the beginning of the cytostome; these are absent in the present species. The name *Leptopharynx chlorophagus* is proposed because of its green ingested food material.

---

[*] Figures in parenthses indicate averages.

Author's sincere thanks are due to Dr. A. P. Kapur, Director, Zoological Survey of India, for the facilities provided, and Dr. S. Khera and Mr. K. N. Nair for encouragement.

Zoological Survey of India,
8, Lindsay Street,
Calcutta-16, *January* 22, 1971.
ASHOK KUMAR DAS.

---

1. Kahl, A., *Arch. Protistenk.*, 1926, 55, 197.
2. —, *Urtiere Order Protozoa I*, in Dahl's *Tierwelt Deutsch.*, 1931, pp. 181.
**3. Levander, K. M., *Acta Fennica*, 1900, 18.
4. Mermod, G., *Rev. Suisse Zool.*, 1914, 22, 31.
**5. Penard, E., *Etudes sur Infusores d' eau douce* (Zusammenfassendes Hauptwork, verf.), Geneve, 1922,
†6. Prelle, A., *C.R. Acad Sci.*, 1962, 254, 4071.
7. Savoie, A., *J. Protozool.*, 1957, 4, 276.

** Not seen in the original.

OCCURRENCE OF A NEW BACTERIAL DISEASE OF INDIAN HONEY-BEES *APIS INDICA* F

THERE had been no reports of any known bee diseases in India till 1957 and it was indeed a congenial situation for the growth of the bee-keeping industry in the country. The first report of occurrence of acarine disease in Indian bees appeared during the fifties[3] in Punjab and this disease has now spread over major parts of north-west India.[2] Shortly after this, the American Foul Brood disease, caused by *Bacillus larvae* White, was noted in Uttar Pradesh.[4]

During August 1970, another disease was observed in colonies at the experimental migratory sites in Karad (Maharashtra) by one of us (V. V. D.) in the course of routine apiary inspection. The samples from these diseased colonies were examined at the Central Bee Research Institute, Poona, by one of us (K. K. K.). In the course of these field and laboratory examinations, a possibility of bacterial Foul Brood disease was tentatively inferred. For a definite confirmation, the samples were sent to: (*i*) the Armed Forces Medical College, Poona, (*ii*) Veterinary College, Bombay, (*iii*) Bhabha Atomic Research Centre, Bombay, and (*iv*) Post-Graduate Research Institute of the Maharashtra Association for the Cultivation of Science, Poona. All these institutions reported the presence of cocci, tentatively assigned to *Streptococcus*. Further critical scrutiny was conducted by two of us (A. V. R. R. and D. R.) arriving at a tentative identification of the pathogen as *Streptococous pluton* (White). The same two co-authors further confirmed this by serological tests employing standard sera, supplied by Dr. L. Bailey of the Rothamsted Experimental Station, Harpenden, Herts, U.K. This, therefore, constitutes the first definitely confirmed report of occurrence of *Streptococcus pluton* (White) causing the European Foul Brood (E. F. B.) disease in Indian honey-bees.

Colonies from experimental apiaries at Mahabaleshwar and Castle Rock are annually migrated during monsoon to Karad where the disease was first noticed during August 1970. Initially this was restricted to colonies brought from Mahabaleshwar, the Castle Rock colonies being relatively free. Therefore, attempts were made to trace back its possible origin from Mahabaleshwar stock. Local enquiries at Mahabaleshwar revealed that during previous seasons (1967-68, 1968-69) there was some mortality of bees and reduction in strength of colonies associated with similar symptoms in the experimental apiary of the Institute located in Blue Valley at Mahabaleshwar. This initial mortality was too meagre to deserve any serious attention then. The fieldmen attending this apiary further reported that the adjacent fresh-water source was frequently visited by the exotic bees from a private apiary within about a mile where a bee-keeper had introduced some *Apis mellifera* colonies from America. Furthermore, these introduced *A. mellifera* bees were migrated by the same private bee-keeper to Poona where the colonies from our experimental apiaries were also migrated for queen rearing programme during monsoon. Both had common foraging fields. A report on the introduction and performance of these foreign bees by this private bee-keeper appeared in local press.[1] It appears that the introduced *Apis mellifera* colonies maintained in this private apiary rapidly dwindled in strength and were presumably lost as their subsequent performance has not been reported, nor are the colonies seen any more. Therefore, it may be reasonable to infer that these introduced foreign colonies could be a possible source of initial infection. This infection is now spreading fast among the local colonies at Mahabaleshwar in the experimental apiaries as well as in the private apiaries. The actual field surveys during December 1970 at Mahabaleshwar indicate about 25-30% of colonies with various grades of infection.

Acarine and Foul Brood diseases of bees, which were unknown in India, have thus appeared here through indiscrete introductions. in spite of the national quarantine regulations. The serious nature of the Foul Brood disease is well known. Therefore, introduction of this new disease constitutes a very grave set-back to the newly established bee-keeping industry in India.

Even before the diagnosis of this new disease as above, the suspected colonies were immediately given a feeding of sugar syrup containing usual concentrations of sulpha-thiozole against the American Foul Brood and terramycin against the European Foul Brood. Colonies treated with the sulpha drug did not recover. Terramycin was found quite effective both *in vitro* tests and feeding tests which again confirms E. F. B.

The authors are grateful to Dr. G. B. Deodikar, Director, M.A.C.S. Research Institute, Poona, and Shri C. V. Thakar, Deputy Director, C.B.R.I., Poona, for guidance and facilities, to Dr. S. V. Amonkar of Bhabha Atomic Research Centre, Bombay, the Principal, Bombay Veterinary College, Bombay, Col. M. C. Bhattacharya, Professor of Pathology, Armed Forces Medical College, Poona, and to Shri M. C. Suryanarayana, Assistant Development Officer (Botany), C.B.R.I., Poona, for cooperation, and to Dr. L. Bailey of Rothamsted Experimental Station, U.K., for the anti-sera.

Central Bee Res. Inst., V. V. Diwan.
Poona-4 ; K. K. Kshirsagar.

Armed Forces Med. A. V. Ramana Rao.
College, Poona-1 ; D. Raghunath.

Apiculture Institute, C. S. Bhambure.
Mahabaleshwar ; and

Maharashtra Assn. S. H. Godbole.
for the Cultivation of
Science Res. Inst.,
Poona-4, *January* 19, 1971.

---

1. Gangal, D., *Maharashtra Times*, 19th January, 1969.
2. Kshirsagar, K. K., *Indian Bee J.*, 1966, **28**, 79.
3. Sardar Singh, *Ibid.*, 1957, **19**, 27.
4. —, *Ibid.*, 1961, **23**, 46.

PRODUCTION OF A GROWTH-INHIBITING TOXIC SUBSTANCE BY *ALTERNARIA TRITICINA* PRASAD AND PRABHU

Alternaria blight of wheat caused by *Alternaria triticina* was first reported in 1962 from India.[1] In recent years, the disease has become very serious in various wheat-growing areas of the country and has been the cause of the failure of a number of high-yielding varieties.[2] The main symptoms of the disease are necrosis of leaf followed by yellowing and stunting in a very short period. The symptoms indicated the elaboration of a toxic metabolite during pathogenesis. A number of species of *Alternaria* are known to produce toxic metabolites which play significant role in the disease syndrome.[3-5] Thus it was considered desirable to study the possible role of toxic metabolites produced by *A. triticina* in the pathogenesis.

One litre flasks containing 200 ml modified Richard's medium containing 0·1% yeast extract were seeded with a suspension of mycelium and spores of a virulent strain of *A. triticina* and allowed to grow for 14 days in still culture or for seven days on a rotary shaker, at room temperature (24-26° C). The culture filtrate was collected by filtering through a Buchner funnel and passed through a bacteria-proof sintered glass filter to remove the remaining mycelia and spores. The sterile culture filtrate thus obtained was used as crude toxins for various tests.

Wheat varieties, Kalyan Sona and NP 830, were used as test plants. The toxicity of the culture filtrate was tested in three different ways. In the first method : 4-week-old wheat seedlings along with intact roots were placed in glass vials containing culture filtrates. In the second method : drops of culture filtrate were applied on the leaf-blades of 3-month-old potted plants. In the third method : the toxicity was tested on the germinating wheat seeds as described by Pringle and Braun.[6] In all the experiments, plain nutrient medium and sterile distilled water were used as control.

The culture filtrate caused severe wilting of wheat seedlings within 18 hours of the treatment. Application of a drop of culture filtrate to leaves produced initial toxic effect as water-soaked spots which became necrotic within 24-28 hours. Typical yellowing of the leaf was observed after 2-3 days. The culture filtrate induced strong inhibition of the development of shoots and roots of germinating wheat seeds and was effective upto a dilution of 1 : 10 (Fig. 1). The toxic substance could inhibit the germination of paddy, maize, moong and gram. Both the resistant and the susceptible varieties of wheat were equally affected by the toxin. The culture filtrate retained the activity even after autoclaving it for 20 minutes at 15 lb pressure.

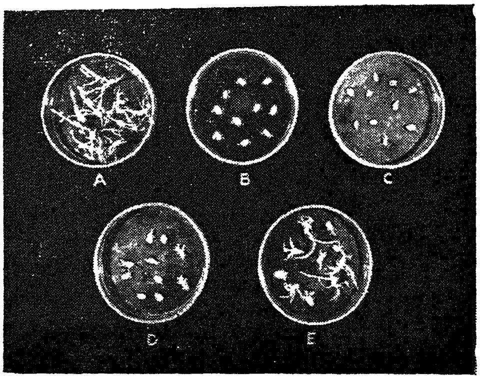


FIG. 1. Toxic effect of culture filtrate on germinating wheat seeds. (A) Control; (B) Filtrate; (C) Filtrate 1:1 dilution; (D) Filtrate 1:5 dilution; (E) Filtrate 1:10 dilution.

Following a modification of the method described by Pringle and Braun,[6] toxic substance was extracted in *n*-butanol, the extract was concentrated under vacuum and the last traces of the solvent were removed. The butanol extract of the culture filtrate, when subjected to thin layer chromatography (TLC) on silica gel using butanol : acetic acid : water (100 : 1 : 15) as solvent system produced only a single spot with Rf value of 0·59. The spot obtained on TLC plate was eluted with water and the toxicity of the elute was tested on germinating wheat seeds. The butanol extract as well as the elute showed potent toxic effect by complete inhibition of root growth of germinating wheat seeds. Butanol extract upto a dilution of 10 ppm caused visible inhibition of root growth of wheat seeds.

The results indicate that *A. triticina* produces a toxic metabolite *in vitro*. As the symptoms produced by the toxic substance are similar to that observed in plants in nature, it is suggested that the toxin may be involved in producing the disease syndrome. The toxic principle was observed to be non-specific in activity and was heat-stable.

Authors are grateful to Dr. A. S. Prabhu of I.A.R.I., New Delhi, for the cultrure of the fungus.

Regional Res. Lab.,
Jammu-Tawi,
January 12, 1971.

R. N. THAKUR.
K. K. JANARDHANAN.
A. HUSAIN.

---

1. Prasad, R. and Prabhu, A. S., *Ind. Phytopath.*, 1962, **15**, 292.
2. Prabhu, A. S. and Prasad. R., *Ibid.*, 1966, **19**, 95.
3. Brain, P. W., Elson, G. W., Hemming, H. G. and Wright, J. M., *Ann. Appl. Biol.*, 1953, **39**, 308.
4. Fulton. N. D., Bollenbacker, K. and Templeton, G. E, *Phytopathology*, 1965, **55**, 49.
5. Sugiyama, N., Kashima, C., Yamamoto, M. and Mohri, R., *Bull. Chem. Soc.* (Japan), 1966, **38**, 2028.
6. Pringle, R B. and Braun, A. C., *Phytopathology*, 1957, **47**, 369.

PRODUCTION OF ORGANIC ACIDS BY CERTAIN SOIL *ASPERGILLI*

IT is well known that *Aspergillus* spp. are efficient producers of organic acids.[1] Fifteen cultures of *Aspergillus* spp. isolated from field soil collected at the Annamalai University Experimental Farm were screened for their ability to produce citric, oxalic, gluconic and kojic acids and the results are reported here.

The fermentation media used by Das and Nandi[2] for citric acid, Bagyaraj and Sirsi[3] for oxalic acid, Das and Nandi[4] for gluconic acid and Hesseltine *et al.*[5] for kojic acid were used in the present study. Each medium was distributed in 100 ml quantities in 250 ml Erlenmeyer flasks and sterilized at 20 psi. A 8 mm disc of actively growing culture of the test organism was inoculated into each flask. After 8 days of incubation at room temperature (28° C), the culture filtrates were tested for the production of four organic acids. The procedures of Millis *et al.*[6] for citric and gluconic acids and Tomlinson *et al.*[7] for oxalic acid were followed for their estimation. The presence of kojic acid in the culture filtrate was tested by the addition of 1 ml of 1% aqueous $FeCl_3.6H_2O$ which gave a bright cherry-red colour.[5] Although other compounds give a similar colouration with $FeCl_3.6H_2O$, most of them are unlikely to be found as fungal metabolites.[1] The production of citric, oxalic and gluconic acids was also confirmed by co-chromatography with authentic samples.

The amount of citric, oxalic and gluconic acids produced by fifteen *Aspergillus* isolates are summarized in Table I. Of the fifteen isolates of *Aspergillus* spp. tested, *A. niger* C. 1, *A. niger* C. 2 and *A. niger* C. 3 have produced maximum amounts of citric, gluconic and oxalic acids, respectively. Interestingly, the three strains of *A. niger* only produced high quanti-

TABLE I

Production of organic acids by Aspergillus *spp.*

Species of *Aspergillus*		Citric acid (g/100 ml culture broth)	Oxalic acid (g/100 ml culture broth)	Gluconic acid (g/100 ml culture broth)
A. niger	C. 1	2·650	0·119	2·074
,,	C. 2	0·800	0·163	2·330
,,	C. 3	1·200	0·175	2·248
A. terreus	C. 1	0·150	0·031	0·00
,,	C. 2	0·200	0·044	0·00
,,	C. 3	0·200	0·038	0·00
A. flavus	C. 1	0·00	0·031	0·00
,,	C. 2	0·00	0·044	0·00
A. fumigatus	C. 1	0·200	0·00	0·00
,,	C. 2	0·200	0·00	0·00
A. striatus	C. 1	0·150	0·00	0·00
,,	C. 2	0·150	0·00	0·00
A. tamarii		0·00	0·013	0·00
A. nidulans		0·00	0·033	0·00
A. japonicus		0·300	0·025	0·00

ties of these three acids than the other *Aspergillus* spp. tested. Of the fifteen isolates tested, *A. flavus* C. 1, *A. flavus* C. 2 and *A. tamarii* only produced kojic acid (Table II).

TABLE II

Production of kojic acid by Aspergillus *spp.*

Species of *Aspergillus*		Kojic acid production
A. niger	C. 1 ..	−
,,	C. 2 ..	−
,,	C. 3 ..	−
A. terreus	C. 1 ..	−
,,	C. 2 ..	−
,,	C. 3 ..	−
A. flavus	C. 1 ..	+
,,	C. 2 ..	+
A. fumigatus	C. 1 ..	−
,,	C. 2 ..	−
A. striatus	C. 1 ..	−
,,	C. 2 ..	−
A. tamarii	..	+
A. nidulans	..	−
A. japonicus	..	−

The organic acids produced by these organisms in the soil might increase the availability of insoluble plant nutrients, especially phosphorus and also serve as carbon sources for certain heterotrophic soil micro-organisms.[8] The kojic acid is highly antibacterial and is more strongly inhibitive to gram-negative bacteria than to gram-positive.[1]

Microbiol. and
Plant Pathol. Section,
Faculty of Agriculture,
Annamalai University, Annamalainagar P.O.,
Tamil Nadu, India, December 10, 1970.

K. N. JAYARAMAN.
N. N. PRASAD.

---

1. Foster, J. W., *Chemical Activities of Fungi*, New York, 1949, p. 648.
2. Das, A. and Nandi, P., *Indian Jour of Microbiology*, 1969 *b*, **9**, 115.
3. Bagyaraj, J. and Sirsi, M., *Curr. Sci.*, 1965, **34**, 458.
4. Das, A. and Nandi, P., *Ibid.*, 1969 *a*, **38**, 469.
5. Hesseltine, C. W., Sovenson, W. G. and Smith, M., *Mycologia*, 1970, **62**, 123.
6. Millis, N. F., Trumpy, B H. and Palmer, B. M., *J. Gen. Microbiol.*, 1963, **30**, 365.
7. Tomlinson, N., Campbell, J. J. R. and Trussell, P. C., *J. Bacteriol.*, 1950, **59**, 217,
8. Martin, A., *Introduction to Soil Microbiology*, New York, 1961, p. 472.

TWO NEW RECORDS OF MARINE WOOD-BORERS (MOLLUSCA: TEREDINIDAE) FROM BOMBAY WATERS

EIGHT valid species of marine wood-borers of the Family Teredinidae have so far been recorded from the Bombay coast.[1,2] These are: (1) *Teredo furcifera* Martens [= *T.* (*Teredo*) *parksi* Bartsch]; (2) *T. clappi* Bartsch; (3) *Dicyathifer manni* (Wright) [= *T.* (*Kuphus*) *manni* Wright]; (4) *Bactronophorus thoracites* (Gould) [= *T.* (*Bactronophorus*) *thoracites* Gould]; (5) *Lyrodus pedicellatus* (Quatrefages) [= *T.* (*Lyrodus*) *pedicellata* Quatrefages and *T.* (*Lyrodus*) *malaccana* Roch.]; (6) *Bankia campanellata* Moll. and Roch. [= *B.* (*Liliobankia*) *campanellata* Moll. and Roch]; (7) *B. nordi* Moll; and (8) *B. rochi* Moll [= *B.* (*Bankiella*) *minima* (Blainville) and *B.* (*Neobankia*) *roonwali* Rajagopal].

During the course of a study on the seasonal intensity of borers, their incidence on chemically-treated wooden panels and on natural durability of different species of Indian timber, two species of shipworms, hitherto unrecorded from the Bombay region, were collected from test panels immersed at Trombay. The two new records are *Nausitora hedleyi* Schepman and *Nototeredo edax* (Hedley). The test panels, harbouring these borers, were examined only a few days after removal from the sea and hence only pallets and shells could be collected. In the case of *N. hedleyi*, two pairs of pallets and shells were collected from panels of *Mangifera indica* Linnaeus and *Albizzia odoratissima* Benth. The tunnels measured 125 mm and 183 mm. Pallets and shells of three specimens of *N. edax* were obtained from panels of beech timber. Their tunnels were 172 mm and 308 mm long and the concamerations at the entrance were found to extend to a length of 43 mm and 55 mm respectively inside the tunnel.

Both the species appear to be very rare in Bombay waters. *N. hedleyi* has earlier been reported from Ernakulam in Kerala State[3] and from Pulicat lake in Tamil Nadu.[4] According to Turner,[5] *B.* (*Nausitora*) *gabriel* Nair, recorded from Ernakulam[6] and from Madras,[7] is a synonym of *N. hedleyi*. Therefore, the present one is the second record of this species from the West Coast of India. Indian ocean islands and Pacific islands are other places from where this species has been reported.

N. edax has so far been recorded from Godavary estuary, near Yanam[8] as *Teredo* (*Dactyloteredo*) *juttingae* Roch., from Tondi in Tamil Nadu[9,10] as *T.* (*Psiloteredo*) *tondiensis* Nair and Gurumani and from Visakhapatnam[11,12] as *T.* (*Teredora*) *thomsoni* Tryon and as *T.* (*Dactyloteredo*) *juttingae*. The present one is the first record of this species from the West Coast of India. It has been reported earlier from Indonesia, Philippines, Pacific Islands, Australia, New Guinea, New Zealand and Japan.

The author is indebted to Shri K. H. Alikunhi, Director, Central Institute of Fisheries Education, Bombay, for guidance and encouragement during the course of this study.

Wood Preservation Centre,
Central Institute of Fisheries Education,
Jayprakash Road, Bombay-58 AS,
December 19, 1970. L. N. SANTHAKUMARAN.

---

1. Palekar, V. C., Santhakumaran, L. N. and Bal, D. V., *Journal of the Timber Dryers' and Preservers, Association of India*, 1964, **10** (3), 11.
2. Santhakumaran, L. N., *J. Bombay nat. Hist. Soc.*, 1966, **62** (3), 580.
3. Saraswati, M., *J. Mar. biol. Ass. India*, 1964, **6** (2), 309.
4. Nair, N. B., *Curr. Sci.*, 1963, **32** (5), 215.
5. Turner, R. D., *A Survey and Illustrated Catalogue of the Teredinidae* (*Mollusca: Bivalvia*), Published by the Museum of Comparative Zoology, Harvard University, Cambride, Mass, 1966.
6. Nair, N. B., *Rec. Indian Mus.*, 1955, **53**, Parts I & II, 261.
7. —, *J. Sci. Industr. Res.*, 1956, **15 C** (3), 81.
8. Ganapati, P. N. and Rao, M. V. L., *Curr. Sci.*, 1959, **28** (8), 332.
9. Nair, N. B. and Gurumani, O. N., *Ibid.*, 1956, **25** (11), 361.
10. — and —, *J. Bombay nat. Hist. Soe.*, 1957, **54** (3), 663.
11. Nagabhushanam, R., *Rec. Indian Mus.*, 1955, **53**, Parts I & II, 1.
12. —, *J. Bombay nat. Hist. Soc.*, 1960, **57** (2), 362.

REVIEWS AND NOTICES OF BOOKS

Annual Review of Genetics (Vol. 4). Editor: H. L. Roman. (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, USA), 1970. Pp. 523. Price $ 10.00.

The *Genetics* series of the Annual Reviews was started in 1967 and the present volume is the fourth in this series. A scrutiny of the index of chapter titles of volumes 1-4, given at the end of the present volume will show that the coverage has been comprehensive and that it has included nearly all areas of recent investigations in genetics, thus bringing the reviews abreast of current developments.

The principles and discoveries of genetics are influencing other biological disciplines. G. E. McClearn writes in this issue of genetic aspects of psychology and the use of genetic tools to dissect the complex activity we call behaviour. Krishna Sameta and R. Levins review the relationship of genetics to ecology.

In the opening chapter on Human Genetics, Victor A. McKusick reviews the subject under the five broad heads: cytogenetics, biochemical genetics, immunogenetics, statistical and population genetics, and clinical genetics.

In the article on Informational Suppression, Luigi Gorini reviews studies in *E. coli* regarding transfer RNA mutations leading to suppression, the physiology of tRNA suppressors and the ribosomal control of suppression. There are three chapters on bacterial genetics: M. Susman writes on General Bacterial Genetics; H. R. Revel and S. E. Luria review investigations connected with DNA-Glucosylation in T-Even Phage, and R. D. Hotchkiss and M. Gabor discuss DNA-DNA confrontation in bacteria genetically transformed by externally added DNA. In the chapter on the Genetics of Bacterial Transport Systems, E. C. C. Lin reviews the ways in which genetic approaches have been used for the analysis of specific membrane transport systems in bacteria.

The other chapters in the volume are concerned with chromosome behaviour, chromosome structure, and extrachromosomal inheritance, fungal genetics, immunogenetics, and hormones and gene expression. A. S. G.

Vistas in Analytical Chemistry. Editor-in-Chief : M. N. Sastri. [Published by S. Chand and Co. (P) Ltd., Ram Nagar, New Delhi-55], 1971. Pp. 408. Price Rs. 50.

This book is a commemoration volume brought out in honour of Prof. G. Gopala Rao on his sixtieth birthday and on the eve of his retirement from the stewardship of the Department of Chemistry, Andhra University, after 36 years of service. Prof. Gopala Rao, who is known for his researches in analytical chemistry, has also served as *Talanta* regional editor for India and Pakistan.

Thirty-three authors have contributed to the nineteen chapters of the book. The major contributions are from laboratories in USA. There are also contributions from UK, Ireland, Australia, Canada, USSR, Brazil, and Shantiniketan in India. The authors are active workers in their respective fields of study. The topics cover nearly all techniques in analytical chemistry and include spectrophotometry, fluorimetry, atomic absorption spectroscopy, nuclear methods of chemical analysis, chromatography, solvent exchange properties, complexometric titrations, chelating agents, differential thermal analysis, functional group analysis, and inorganic ultramicroanalysis, etc.

The book will be useful to students and workers in the field of analytical chemistry.
A. S. G.

Guide to the Bird Gallery of the Government Museum, Madras. By S. T. Satyamurti. (The Director of Stationery and Printing, Madras), 1970. Pp. xii + 195. Price Rs. 11·30.

The author who is the Director of Museums, Madras, has brought out this useful guide-book to help the visitors of the bird gallery of the Madras Museum. The exhibited specimens consist mostly of stuffed and mounted birds, depicted as far as possible in their material, life-like attitudes.

The book gives brief outlines of the habits and other characteristic features of the species of birds exhibited. The book contains 100 plates, a few of them coloured, and an appendix containing the scientific names of the birds and their Tamil equivalents.

Though the guide is intended for the visitors of the Museum, it will be useful to bird-watchers and laymen interested in the avifauna of South India. A. S. G.

National Institute of Nutrition. (Annual Report). (National Institute of Nutrition, Indian Council of Medical Research, Hyderabad-7, India), 1970. Pp. 140.

The Nutrition Research Laboratories, Hyderabad, have been known over the years for their pioneering work on various problems of nutrition of the country. Since their new recognition in 1968 as the "National Institute of Nutrition", the Institute has been functioning as an important unit of the Indian Council of Medical Research (ICMR) and the activities of the laboratories have been intensified and also expanded. Working in collaboration with other allied national organizations such as the Indian Council of Agricultural Research (ICAR), the Nutrition Institute has added new fields of studies both on the basic and applied aspects of nutrition. Thus, the Institute conducts fields studies, and has in its training programme, regular courses for certificates, diplomas, and post-graduate degrees in nutrition, besides *ad hoc* courses on various aspects of applied nutrition. These are attended by students not only from India but also those sponsored from other South-East Asia countries.

The annual report under review covers the period 1st October 1969 to 30th September 1970, and presents in brief the results of major investigations continued and newly undertaken during the year. The investigations reported are concerned with nutritive values of foods and their fortification, toxins in foods, studies on vitamins and nutrition requirements, interaction between nutrition and infection, and between nutrition and hormones, amino-acid imbalances in nutrition, the role of leucine in pellagra, studies on pregnancy, malnutrition and mental development, etc. A. S. G.

ANNOUNCEMENTS

Summer School in Solid-State Physics

A Summer School in Solid-State Physics will be held at the Indian Institute of Science, Bangalore, from June 23 to July 9, 1971, under the auspices of the Tata Institute of Fundamental Research, Bombay. The principal speakers are Professor W. J. Huiskamp, Kamerlingh Onnes Laboratory, Leiden—Electronic and Nuclear Spin Systems at Low Temperatures; Professor K. P. Sinha, Indian

Institute of Science, Bangalore—Theory of Super-conducting State in Pure and Impure Solid Materials ; and Dr. A. Jayaraman, Bell Telephone Laboratories, U.S.A.—Physics of Solids at High Pressures.

The courses are meant for active research workers in the field of experimental and theoretical Solid-State Physics. Request for participation in the School should be sent to Dr. Girish Chandra, Tata Institute of Fundamental Research, Homi Bhabha Road, Colaba, Bombay-5, to reach before April 17, 1971.

Eighth International Symposium on the Chemistry of Natural Products

The Eighth International Symposium on the Chemistry of Natural Products will take place during the period 6-12 February, 1972, in the buildings of the Indian National Science Academy, New Delhi. There will be ten plenary lectures by distinguished scientists. Details will be given in Circular 2. The Scientific Programme Committee will consider papers of special interest and novelty in any branch of Natural Products Chemistry. The Symposium will be devoted mainly to the following topics for which it is proposed to organise separate sections : (A) Alkaloids ; (B) Polyphenolics ; (C) Terpenoids and Steroids ; (D) Macromolecules of Biological Interest (Proteins, Peptides, Nucleic Acids, etc.) ; (E) Carbohydrates, Lipids and Related Substances ; and (F) Other Topics in Natural Products Chemistry including Physical Methods of Structure Determination.

Members wishing to present a paper at the Symposium are required to submit an abstract and to complete the application form to be distributed with Circular 2. The abstracts and the applications to contribute a paper for the meeting must reach the Secretary not later than 1 September, 1971.

Award of Research Degrees

Karnatak University, Dharwar, has awarded the Ph.D. degree in Botany to (Miss) B. N. Kanmani ; Ph.D. degree in Chemistry to Shri L. D. Basanagoudar.

The Maharaja Sayajirao University of Baroda, has awarded the Ph.D. degree in Chemistry to Shri Ram Atmaram Balani, and Shri Rasiklal Jamnadas Chudgar ; Ph.D. degr in Physics to Shri Thakorbhai Ramchanc Joshi ; Ph.D. degree in Botany to Kumari Kamalavalli and Kumari Ishwari Gangar Lalchandani ; Ph.D. degree in Civil Enginee ing to Shri Vishwanath Shridhar Thattey.

Sri Venkateswara University has award the Ph.D. degree in Zoology to Smt. G. Jay lakshmi ; Ph.D. degree in Chemistry to Shri Krishna Reddy and Shri V. Rangaiah.

Utkal University has awarded the Ph degree in Zoology to Shri T. Seshagiri Ra Ph.D. degree in Chemistry to Shri S. Mohanty ; Ph.D. degree in Botany to Shri Devadath.

Osmania University, Hyderabad, has award the Ph.D. degree in Chemistry to Smt. Vijaya Lakshmi.

ICAR Grant

The Current Science Association ackno ledges with thanks from the Indian Coun of Agricultural Research, New Delhi, the ceipt of a grant of Rs. 5,000 towards the pu lication of its journal, *Current Science*, duri the year 1970-71.

International Conference

The Fifth International Vacuum Congr and the International Conference on Solid Su faces will be held in Boston (U.S.A.) fr 11th to 15th October 1971.

Books Received

Fortschritte der Experimentellen und Theo tischen Biophysik—Biophysik des Musk By Beir Leipzig and E. Ernst. (Veb-Geo Thieme, Leipzig, Absatzabteilung, DDR-Jena, Villengang-2), 1970. Pp. 71. Pr 18 Marks.

Atoms, Molecules and Chemical Reaction Chemistry from a Molecular Point of Vi By S. W. Benson. (Addison-Wesley Pub. C Reading, Massachusetts), 1970. Pp. ix + 1 Price 35 *sh*.

Algebraic Number Theory. By Serge La (Addison Wesley Pub. Co., Reading, Mass chusetts), 1970. Pp. xi + 354. Price 140

Probability and Statistics. By Harry Lass a Peter Gottlieb. (Addison-Wesley Pub. C Reading, Massachusetts), 1970. Pp. ix + 4 Price 121 *sh*.

2691-71. **Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.**

PREFACE

Towards the end of his life, Professor Raman was President of the Current Science Association for many years and devoted a great deal of his time to raise the standard of this fortnightly journal of science. He used to write frequently for the journal and if it is what it is today, it is due to his efforts in a large measure. The Association feels privileged to bring out this Raman memorial number, to which several of his former colleagues and students have kindly contributed. The articles published cover a wide range of his interests and bring out many facets of the colourful personality of that great genius, who was an inspiration and guide to a whole generation of Indian scientists. That Professor Raman's interests ranged over a wide canvas covering subjects like meteorology, astronomy and physiology besides physics ; that he was essentially a child of Nature, passionately seeking true knowledge and that nothing could make him give up his chosen pursuits which he followed with unswerving devotion are all evident from what the contributors to this memorial number have written. It will be no exaggeration to say that for many generations to come, Indian scientists will regard him as the Father of Modern Science in India and will emulate the traditions that he has left behind him. On behalf of *Current Science*. which he conducted and nursed for years with devotion, energy and enthusiasm characteristic only of himself, we pay our homage to the memory of Professor Sir Chandrasekhara Venkata Raman.

BANGALORE,
May 5, 1971.

S. BHAGAVANTAM,
President,
Current Science Association.

[redacted]

PROFESSOR SIR CHANDRASEKHARA VENKATA RAMAN, N.L. FOUNDER-PRESIDENT OF THE INDIAN ACADEMY OF SCIENCES AND FOUNDER-DIRECTOR OF THE RAMAN RESEARCH INSTITUTE, BANGALORE— THE YEARS PRECEDING THE DISCOVERY OF THE RAMAN EFFECT

K. R. RAMANATHAN

Physical Research Laboratory, Ahmedabad-9

CHANDRASEKHARA VENKATA RAMAN was born on 7 November 1888, at Tiruchirapalli, an important South Indian city on the banks of the river Kaveri. His father, Sree Chandrasekhar Iyer, was a teacher in a local High School. A few years after Raman's birth, Chandrasekhar Iyer accepted a post of Lecturer in Mathematics and Physics in the Hindu College at the sea-coast town of Visakhapatnam (Waltair). He was greatly interested in music and could play like a professional on many musical instruments. Raman's mother came from a family of Sanskrit scholars. Music, Light and Colour in Nature, rivers, seas, skies, mountains, forests and flowers had a fascination for Raman from his early childhood. Till the last day of his dedicated life, this wide-eyed gifted Child of Nature looked with penetrating eyes at different manifestations of Nature and laboured unceasingly to probe into their inner workings. His success in unravelling some of Nature's deeper secrets, and communicating some of his own enthusiasm for science to young people of all ages, both scholars and laymen, was outstandingly great.

At a lecture delivered at Bangalore on 16 March 1928, Professor C. V. Raman announced the discovery made in the laboratories of the Indian Association for the Cultivation of Science, Calcutta, of the appearance of new radiations in the light scattered from several kinds of substances and briefly discussed the importance of the discovery. The announcement received immediate world-wide attention. Intense work followed, and a few months later, in July 1928, Prof. Raman and Krishnan communicated a short paper of less than 12 pages to the *Proceedings of the Royal Society*, in which they summarised the knowledge gained in the first few months after the discovery. For the great significance of the results and beauty of presentation, the paper is a classic in scientific writing.

The paper starts off in the following way:

"In two preliminary papers, we have recorded the discovery that when monochromatic light is scattered by a transparent medium (be it gas, vapour, liquid, amorphous solid or crystal), the diffused radiation ceases to be monochromatic, and several new lines or sometimes bands (associated in many cases with a continuous spectrum) appeared in the spectrograms of the diffused radiation. Further, the radiations are, in general, strongly polarised.

Our preliminary studies have proved conclusively that the effect arises in the following way. The incident quantum of radiation is either scattered as a whole, in which case we have the classical scattering, or else is absorbed in part by the molecules of the medium, the remaining part appearing as a scattered quantum. The part absorbed shifts the molecules to a level of energy different from the initial state. Our experiments furnish definite proof of the possibility of such processes, and show that they may occur also in such complicated systems as the molecules of a vapour or a liquid or even a complete crystal."

In the course of the paper, the authors point out that the differences between the incident and scattered frequencies correspond to characteristic infra-red frequencies of the molecules and that several molecular frequencies, hitherto unknown, appear in these differences.

Three years later, in December 1930, when awarding the Hughes Medal of the Royal Society to Sir C. V. Raman, Lord Rutherford said as follows:

"Sir Venkata Raman is one of the leading authorities in Optics, in particular on the phenomenon of the scattering of light. In this connection, about three years ago, he discovered that the light's colour could be changed by scattering. This had been predicted sometime before, but in spite of search, the change had not been found. "The Raman Effect" must rank among the best three or four discoveries in Experimental Physics in the last decade. It has proved and will prove, an instrument of great power in the study of the theory of solids. In addition to important contributions in many fields of knowledge, he has developed an active school of research in Physical Science in the University of Calcutta," In the same year (1930), the Nobel Prize for Physics was awarded to Sir C. V. Raman.

It is interesting to enquire how a fundamental discovery like this came to be made in India, and in 210, Bowbazar Street. The obvious answer is that Sir C. V. Raman was there in 210, Bowbazar Street, to make the discovery, and that he had been there for the previous twenty years building up step by step, with his students, the necessary background of knowledge and atmosphere. I give below a brief sketch of this constructive work.

C. V. Raman was an exceptionally gifted student. A very early paper of his in Optics on "Unsymmetrical Diffraction Bands Due to Rectangular Aperture" was written when he was about 18 years old, a student in the Presidency College, Madras. Bright students there are every year, but students who produce first-rate research papers in their teens are rare. Three of Raman's research papers were published in 1906-07 in the *Philosophical Magazine* and *Nature*.

Soon after taking his M.A. degree in Physics with the highest honours, C. V. Raman joined the Government of India as an Officer of the Finance Department. Raman's interest in physics continued unabated, and wherever he was posted, whether in Calcutta, Rangoon or Nagpur, he continued to do research work and regularly contributed papers (mainly in acoustics) to scientific journals. In Calcutta, he made a discovery. In 210, Bowbazar Street, a busy thoroughfare of Calcutta, there was an old institution called the Indian Association for the Cultivation of Science, with a laboratory and library established in 1874 by an enthusiast for Science, Dr. Mahendralal Sircar. Except for occasional lectures, the Association had lain dormant for years. The institution had many spacious rooms with a good collection of old apparatus mainly of the demonstration variety. Raman requested the authorities to give him permission to work in the Institution. This was readily granted and Raman took up a house adjoining the Institution, had a door opened between his house and the Association so that he could reach the Laboratory informally for work at any time, by day or by night. A steady flow of brilliant scientific papers. mainly on vibrations of strings and their maintenance and of musical instruments of the violin, veena and tabla families commenced. Raman also started giving evening lectures at the Association, expounding in his characteristically brilliant style with impressive demonstrations the results of his scientific investigations. All this naturally attracted the attention of Sir Ashutosh Mookerji who was then the Vice-Chancellor of the Calcutta University. When Sir Ashutosh was able to induce Sir Tarak Nath Palit to create Professorships in Physics and Chemistry in the Calcutta University, he immediately offered Prof. Raman the Chair of Physics. Professor Raman accepted the offer and, in 1917, when he was 29 years old, resigned his post in the Finance Department and became whole-time Professor of Physics.

The Association rapidly became an active centre of research. Several alumni of the Calcutta University, Dr. S. K. Banerji, Dr. B. Banerji, Dr. S. K. Mitra, Dr. P. N. Ghosh, Dr. N. M. Basu, Dr. B. B. Ray and others joined Professor Raman to work for their post-graduate degrees, also scholars from outside Calcutta like Mr. Chinmayanandan, Prof. Sethi, Dr. R. N. Ghosh and Dr. N. K. Sur. Optics and Acoustics were the main subjects of study. The Indian Association for the Cultivation of Science at 210, Bowbazar Street, and the University College of Science, 92, Upper Circular Road, became the main centres of scientific research in India. Problems on the interference and diffraction of light, and the scattering of light by large particles which are responsible for sunset colours, coronae and brocken-bows received special attention.

I went to Calcutta in December 1921 to work under Professor Raman and first met him in the rooms of the Indian Association for the Cultivation of Science. He had returned a few months previously from his first visit to Europe. His voyage across the wide seas had brought him face to face with a natural phenomenon of great grandeur and beauty, namely the colour of the deep blue sea. During the voyage, he had studied various aspects of the light from the sea and sky with characteristic freshness of mind and came to the conclusion that the theories so far advanced to explain the deep blue colour of the sea were inadequate and that the primary origin of the blue colour of the sea was fundamentally the same as that of the blue of the sky, namely, the scattering of light by water molecules themselves modified by absorption in the red, and was not dependent on the presence of any suspended matter. After his return to India, he repeated and extended the experiments of Lord Rayleigh (the younger Rayleigh) on the scattering of light in dust-free liquids and sent a brilliant and comprehensive paper on the Molecular Scattering of Light in Water and the Colour of the Sea to the Royal Society. (*Proc. Roy. Soc.*, 1922.) In this paper, he made use of the Einstein-Smoluchowski formula of scattering based on the thermodynamical fluctuations of density in fluids, to calculate the intensity and polarisation of the light scattered by sea-water. Mr. K. Seshagiri Rao, who was later an Examiner of Patents in Calcutta, was making quantitative measurements in the Laboratory to test with what accuracy the Einstein-Smoluchowski formula was obeyed in liquids under ordinary conditions.

There were other workers in the laboratory engaged on various problems in Optics or Acoustics. Prof. Laljee Sreevastava of Ajmer was working on the scattering of light by transparent crystals; ice and rock-crystal or quartz were the main crystals under study. Professor Raman had observed the blue colour of deep glaciers in the Alps. Professor Tamma of Meerut was working with crystals of sugar-candy and sulphur on the phenomenon of Internal Conical Refraction, Dr. Panchanan Das was working with paper and pencil on problems of vibrations of strings with frequent admiring recitals from Sommerfeld's 'Atombau' and Mr. V. Venkataramaiah of Vizianagram was setting up some glass apparatus or other for studying the properties of suspected H_3 (triatomic hydrogen). L. A. Ramdas and K. S. Krishnan were still students in the University College and Ramdas used to flit in and out of the laboratories of the Association, regaling his friends with music and jokes. Mr. Krishnan was an occasional visitor.

The next two years were years of intense activity in the development of the subject of classical molecular scattering by liquids and gases both in its experimental and theoretical aspects. The influence of the optical anisotropy of the molecules on scattering, scattering near the critical point in fluids and in mixtures of fluids, the problem of X-ray scattering in fluids, the systematic and methodical study of the scattering of light by different liquids, all these received attention and substantial progress was achieved.

One curious fact which appeared in my observations of scattered light from the deep blue water of the Bay of Bengal and from pure dust-free distilled water and also from pure methyl and ethyl alcohols was that when blue light was used to illuminate the medium, the scattered light had in addition a trace of light of longer wavelengths. This was at first attributed to "a feeble fluorescence". The same effect was found in many other liquids by Mr. K. S. Krishnan and Mr. S. Venkateswaran. Professor Raman did not feel satisfied with the explanation that the phenomenon was due to fluorescence and wondered whether this might not be akin to the Compton effect in X-ray scattering. When in 1927, Venkateswaran found that the colour of sunlight scattered by glycerine was a bright green instead of blue and that it was strongly polarised, Prof. Raman decided to probe into the matter in greater detail with the assistance of Mr. K. S. Krishnan and Mr. Venkateswaran. Intensive work using monochromatic incident light eventually led to the discovery of the great effect, the story of which has been told by Prof. Raman himself at the meeting of the South Indian Science Association at Bangalore on 16 March 1928, and in greater detail in the Royal Society paper by Prof. Raman and Mr. K. S. Krishnan ("The Production of New Radiation by Light Scattering: Part I", *Proc. Roy Soci.*, A, 122, 23–35, 1929) and in Professor Raman's Nobel Lecture in 1930.

A related field in which Professor Raman and Mr. K. S. Krishnan carried out a large amount of experimental and theoretical work between 1924 and 1927 was electric and magnetic double refraction in gases, liquids and crystals and their relation to the optical anisotropy of the molecules.

About a year after the discovery of the Raman Effect, Krishnan accepted the post of Reader in Physics in the Dacca University and together with his students, carried out his well-known pioneer studies on magneto-crystallic action. The subject of Crystal Physics was later developed in great detail by Bhagavantam and his group at Waltair, and Prof. Raman himself and Dr. R. S. Krishnan and their students at Bangalore. All these had their seeds in the work done in Professor Raman's Laboratories in Calcutta in the twenties.

The atmosphere in the Association when I worked there was one of great informality and extreme cordiality. All the workers lived either in the corner rooms of the Association or in rooms very near the Association; work went on from early morning till sunset with short intervals snatched for food and other personal requirements. The Assistant Secretary, Mr. Ashutosh Dey or Ashu Babu as he was affectionately called, with his loud voice and hearty laughter was always available to make all arrangements required for work and was the presiding deity to arrange all the smaller but none-the-less essential requirements for work—just as Professor Raman was the Central Sun round which the whole Institution revolved and from which each part derived its energy.

It still gives me a thrill of pride to think that I was privileged to work in those premises in those days and take a small share in the vital activities of the Association during the period 1921-24. After I went to Rangoon as a Lecturer in the University in late 1922, I continued to be a periodic visitor to 210, Bowbazar, during summer vacations each year till I joined the India Meteorological Department in 1925. Later, Mr. K. S. Krishnan and Mr. Bhagavantam joined the Laboratory as full-time workers. Mr. S. Venkateswaran, who had a job in the Alipore Test House, was a whole-time morning and evening worker.

In this context, I wish to quote a statement made by Prof. Raman in the broadcast talk on "The Scientific Outlook".

"The principal requisite for success in scientific research is not the maturity of knowledge associated with age and experience but the freshness of outlook which is the natural attribute of youth.

The principal function of the older generation of scientific men is to discover talent and genius in the younger generation and to provide ample opportunities for its free expression and expansion."

In 1933, Prof. Raman left Calcutta for Bangalore on appointment as Director and Professor of Physics in the Indian Institute of Science. In 1934, he founded the Indian Academy of Sciences and became its President. *The Proceedings of the Academy* (Sections A and B) have since been published regularly every month without a single break. At the Indian Institute of Science, Prof. Raman and his students made extensive studies on Raman and infrared spectroscopy, X-ray spectroscopy, Brillouin scattering, ultrasonics, colloid optics, various aspects of crystal physics, etc.

In 1935, the Government of Mysore gifted to Professor Raman, as President of the Indian Academy of Sciences, 11 acres of land for constructing laboratories, libraries and other facilities for scientific work. A few years before his retirement from the Institute in 1948, Prof. Raman had arranged to build a new Research Institute, which now goes by the name of Raman Research Institute. After 1948, Prof. Raman continued to work in this Institute on the physical properties of crystals in relation to their structure, colours of minerals, iridescent shells, flowers, etc. Problems of floral colours and the Physiology of Vision interested him in the last few years of his life. Raman was very happy when, in 1964, the laser was applied to Raman Spectroscopy and the Raman Effect began to be used to solve more difficult problems of molecular structure, and unstable particles in chemical reactions.

In September 1970, Professor Raman organized a whole week's meeting of the Indian Academy of Sciences at Bangalore. Young scientists were invited to present reviews of progress in different subjects—Nuclear Science, Radio Astronomy, Meteorology, Seismology, Crystallography, Genetics, Agricultural Science and Neuro-physiology. In spite of failing health, Raman attended all the meetings and, as usual, took an enlivening part in all of them.

Prof. Raman had a breakdown early in November and he passed away peacefully on the morning of 21 November 1970. His life companion, Lady Lokasundari Raman, and his Astrophysicist son, Radhakrishnan, were with him in his last days. His bodily remains were cremated on the grounds of the Institute.

Professor Raman's scientific achievements and infectious enthusiasm for science attracted motivated young men from all parts of the country. He trained them in scientific research and instilled self-confidence in them. When they went out into the world, they could grow on their own and create schools of research in Universities, or, entering scientific services of Government, invigorate and improve them by research and development. Raman himself remained till the last days of his long and dedicated life, the wide-eyed Child of Nature, inquisitive about all aspects and phenomena of Nature and their inner workings. Again, quoting from one of Raman's broadcast talks: "Intellectual beauty is indeed the highest kind of beauty. Science is the fusion of man's aesthetic and intellectual functions devoted to the representation of Nature. It is therefore the highest form of creative art."

May the example and memory of Professor Raman's life and work, his courage, his faith in young men and women, and his ceaseless quest for Truth be an inspiration to the young people of our country.

THE RAMAN EFFECT

S. BHAGAVANTAM
Indian Institute of Science, Bangalore

PROFESSOR RAMAN started working on the scattering of light by matter in 1921. In 1922, he wrote a monograph entitled *Molecular Diffraction of Light*, which was published by the Calcutta University Press. By 1924, he made such noteworthy progress that he was invited to open a symposium on the subject at a meeting of the British Association in Toronto. In 1928, he discovered the phenomenon that now bears his name—the Raman Effect. In 1930, he was awarded the Nobel Prize in Physics. Thus, it took him just nine years to climb to the top, starting from the scratch.

During the presentation speech, the Chairman of the Nobel Committee for Physics said: "the Raman Effect has already yielded important results concerning the chemical constitution of substances; and it is to foresee that the extremely valuable tool that the Raman Effect has placed in our hands will, in the immediate future, bring with it a deepening of our knowledge of the structure of matter." That, during the forty and odd years that have since gone by, many thousands of papers have been published by scientists working in several countries and in widely varying disciplines, that numerous problems of importance have been solved and that some unexpected ramifications of the subject have come to light in recent years is a most gratifying fulfilment of such an anticipation, pronounced so soon after the discovery and in such a forthright manner. Today, the Raman Effect stands as the pinnacle of India's contribution to world science.

It was known for a long time that light is diffused laterally with varying degrees of intensities by matter in all states of aggregation. When a beam of white light is condensed by means of a lens into the centre of a large glass bulb containing a dust-free liquid like benzene, an observer who shields himself from the direct rays of the source and views the track in the liquid in a transverse direction, will at once see a magnificent blue scattering. This rather easily performed experiment was always explained by attributing the blue colour to a relative enhancement of what is already present in the source. It was never expected that during the process of scattering, it was at all possible that in addition to what is present in the source, light of frequencies not present in the source can be generated and therefore detected in the scattered beam. Professor Raman, by using a simple device of inserting appropriate filters in the paths of incident and scattered beams in the beginning and by using monochromatic sources later, discovered that some new frequencies not present in the incident light appear in the scattered beam as a result of, so to say, interaction between molecules of the radiated substance and the incident radiation. Thus, in the spectrum of the light scattered by a substance, the Raman Effect discloses itself by the presence of new lines adjacent to the original lines of the incident light. The effect may be briefly defined as follows: when a transparent substance is radiated with monochromatic light, a portion of the incident radiation is scattered by the substance in all directions. While a large part of the light thus scattered possesses the same frequency as that of the incident radiation (Rayleigh scattering), a small fraction thereof consists of light which has undergone a change of frequency (Raman scattering), the extent of change being characteristic of the substance.

It is best to quote here what Professor Raman himself wrote, nearly 40 years after the discovery, about how he was led to make the discovery.

"Later, I became aware of the remarkably brilliant monochromatic illumination which could be obtained by the aid of the commercially available mercury arcs sealed in quartz tubes. Towards the end of February 1928, I took the decision to make use of such lamps for all further studies in the field of light-scattering. The success which attended this forward step was immediate and highly gratifying. Experience in working with sunlight indicated the techniques necessary for the observation of extremely weak phenomena, *viz*., the rigorous exclusion of stray light and the conditioning of the observer's vision by a prolonged stay in darkness. On setting up the apparatus and making these preparations, I found that the light of the mercury arc diffused by various materials when examined through a direct vision spectroscope showed the presence, besides the lines of mercury, also of other lines the positions of which varied with the substances under study. Amongst the numerous materials thus examined was a large block of clear ice. This showed sharp displaced lines in the spectrum of the scattered light in approximately same positions as the rather diffuse bands observed with pure water. Within a few days of the discovery, photographic spectra were successfully recorded in which the additional lines showed up very clearly."

Today, intense sources of radiation and powerful spectrographs are available for Raman studies. Techniques have been greatly improved and automatic recording devices pressed into service. The discovery of Laser action and Laser sources has introduced a new dimension to the phenomenon. The Raman spectrum of a new substance has now come to be regarded as its signature and is invariably studied.

It is of particular significance that the equipment which Professor Raman employed consisted of three items, namely, a mercury lamp, a flask of benzene and a direct vision spectroscope, all of which would be regarded as crude instruments at the present time. Even at that time, these would by no means qualify for being classed as sophisticated or expensive items. On the contrary, they were available to many physicists all the world over in every laboratory worth its name. Great discoveries always appear incredibly simple, but alas only after some devoted individual has made the discovery.

PROFESSOR RAMAN, "THE SCIENTIST-SAVANT" I ADMIRED

T. S. SADASIVAN

Director, Centre for Advanced Studies in Botany, University of Madras

WHO can write a near complete appreciation of our most colourful and dynamic personality of the community of scientists of modern India? Who, indeed, could dare attempt to fathom the intellectual brilliance of a unique personality India lost on that fateful day, November 21, 1970? To many, he was just Sir C. V. Raman, a venerable figure full of honours and the tallest among Indian scientists of this century, but to some of us who were admitted into his 'inner court' he was THE PROFESSOR which conveyed everything that the title signified. Whether we belong to diverse discipline of biology, physics, mathematics or the earth sciences, he was our guiding star and we looked upon him not only as a Nobel Laureate in Physics but also as a sole representative of a fast dwindling group of scientists who could be called Naturalist-Philosophers. For, who could have the courage to enter into fields like the Physiology of Vision or Floral Pigments (he coined a word 'Florachrome') or the colour of the sky or the oceans and make significant contributions?

Ever since he built his own Institute, Professor Raman's wide interests in science became more apparent than ever. His collections of natural objects ranged from colourful minerals to diamonds, rubies and sapphires; every type of musical instrument from the mridangam to the violin; from birds, beetles and butterflies to the finest collection of roses, bougainvilleas and jacarandas; stately trees from the common eucalyptus to the rare mahogany—indeed, he was literally surrounded by a fantastic array of biological materials. I can never forget the way he laid two similarly dressed ores of copper and gold in the palms of the late Prime Minister Pandit Jawaharlal Nehru when he visited his Institute and switched on the ultra-violet light and asked the Prime Minister as to which was copper and which gold. The brighter piece under the ultra-violet light was promptly named gold by the Prime Minister and Professor Raman in his inimitable way burst out: "Mister Prime Minister, all that glitters is not gold."

Professor Raman had some very definite views on fundamental research as Society's soundest investment for the future. He, nevertheless, conceded that while technological innovations had their own marketplace importance, the future of science unquestionably demanded a high place for fundamental research and the scientific community would have to understand the rationale of it all and make science play a positive role in our society than ever before. While he did not deprecate the interdisciplinary approach in many new fields of specialization, Professor Raman made no apologies about the awkwardness of groups of investigators sniffing around another's field of research for which they did not have the necessary training or competence.

In recent years, the Professor was much concerned with the rather poor quality of a good proportion of scientific papers that were submitted to Indian journals for publication. Despite this, he would promptly intercept any discussion at meetings on the need for tightening our systems of refereeing and declare: "Each man stands or falls by his own scientific writings." There can be little doubt that men of science in India owe a deep debt of gratitude to Professor Raman for his farsight in establishing the *Proceedings of the Indian Academy of Sciences* and the *Current Science* which have given generations of young men an excellent medium for projecting their scientific data. These organizations by themselves could make exacting demands on a scientist's time, but Professor Raman viewed it differently as his life's mission and a gift to the nation. Indeed, no sacrifice in the cause of science was too much for him: he gave his all to science.

Intensely national, on many occasions in recent years, Professor Raman had said in no unmistakable terms of his abiding and abundant faith in the young scientists of this country and this made him feel not so desperate as others when they took a dim view of the depletion of bright young scientific personnel through the much-publicized "brain drain". On the occasion of opening of a laboratory, Professor Raman asked in a cryptic way: "Where are the brains to put into this magnificent building; remember, Radium was discovered in a tin-shed!" The proper attitude to science and scientific research was to him more important than major achievements which is given to the lot of very few men of science even in the most advanced countries.

I would like to end with a personal note. Looking back on my long association with this great savant, I can understand the big void the passing away of Professor Raman has created in Indian Science. He was one of those rare courageous men who would call 'a spade a spade'. He would suffer no fools. I am reminded of a memorable occasion when many spoke at a special function got up to honour Professor Raman on his 80th birthday at one of the Annual Sessions of the Academy at Ahmedabad. When the last speaker had finished, Professor Raman appreciated the many warm sentiments expressed but pointed out, with a twinkle in his eyes, to the singular absence of any reference to one quality he proudly cherished: "I wish someone had said that I had the heart of a lion!" In fact, what I admired in him most was his simplicity and high thinking, indomitable in defeat and insatiable in victory.

We shall miss him at the Annual Sessions of the Indian Academy of Sciences and his brilliant Presidential Addresses and scintillating after-dinner speeches, we shall miss him at the Council Meetings of the Academy held in his Institute under charming wooded surroundings, we shall miss him when we are in need of encouraging advice and wise counsel and we shall miss him most when a bold and authoritative voice would be needed to silence dilettantish attempts at introducing new science policies in our country in future.

PROFESSOR RAMAN'S GIFT TO OUR NATION

T. R. SESHADRI
Emeritus Professor, Department of Chemistry, University of Delhi

IN recent years, increased emphasis has been laid on the need for changing the writing of history. It should not be simply a record of kings' reigns and wars and revolutions but should deal with more subtle and important factors that affect society and culture. In the evolution of the new complexion, historians of the right type should rise and be able to cope with the newer and ever-increasing demand on their ability and capacity to deal with factors that build up the mind and spirit of a nation. In this respect, Prof. Raman's life and work should be considered to be of great value for the progress of modern India.

The progress of a developing nation is somewhat akin to a man running uphill. This effort requires strength and experience. For the nation these are provided by institutions and traditions. The former represent the long shadows of great personalities who built them and the latter the disembodied spirit left behind by great workers and leaders and animating the nation. These two should be cherished as cumulative treasures by any nation that has success as its goal. In the area of science, Prof. Raman has left us both and they have to be preserved and cherished. It is significant that he valued science as his religion and this attitude of his may be understood and appreciated in the following two main aspects: (1) In the modern age of science, the welfare of a nation depends ever so much on the development of science, that its elevation to the level of religion with all its important implications becomes essential. (2) In a country like ours, religion has all along provided the basic inspiration for all worthwhile progress, revolution and renaissance and if science should make a marked impact, it should derive its strength from religion and should be associated with it in every way.

Well-developed institutions act as eternal springs of ideas and inspirations. Scientists are familiar with the Cavendish Laboratory in Cambridge, the Kaiser Wilhelm Institutes in Germany and the famous Institutes of the Academy of Sciences in U.S.S.R. These Institutions do not age; on the other hand, they grow bigger and stronger with the passage of time. Neglect is a serious disease for them and will spell the nation's loss and diminution of strength just ~~as~~ in the case of a hall with damaged pillars. This neglect has been the cause of the backwardness of many nations. One of the characteristics that has been noted in backward communities is the repetitive process of unfruitfulness: doing, undoing and redoing. They lack the vision and the strength for maintaining and growing steadily to achieve progress. Prof. Raman has left us the Indian Academy of Sciences, Raman Institute and the journals associated with them, including *Current Science,* which he founded and conducted with energy and devotion all through his life. It becomes the nation's responsibility that they should be cherished and allowed to function with increasing efficiency. In the long but chequered history of most civilized nations, forts, palaces and similar military and political institutions were frequently destroyed by hostile forces and newer ones built. But continuity has been possible in the case of religious institutions. In spite of fanatical attack by certain religious groups, these institutions have continually functioned because of the protection given by the people. To some extent, some scientific institutions have also received this protection. Since science is an increasing force in modern times and has to advance progressively and rapidly, scientific institutions should naturally receive the devoted care of a nation. The success of most advanced countries lies in their efficiency in this direction. It should be remembered that scientific discoveries like the Raman Effect are the results of supreme mental and intellectual effort and dedication and should be valued for their cultural impact besides appreciation for the advance of science and arts.

Prof. Raman entered science like a fish jumping into water and was happy to do so; but this happened at a time when science was not attractive and was not prosperous. By dint of concentration, persistence and devotion to science, he was able to create an atmosphere and tradition which has a permanent value. These are intangible effects which are difficult to understand and follow up, but they have to be retained and cherished. We should pray that his example and his spirit will stay and grow and our scientists will be adequate in their strength to imbibe and cultivate the Raman spirit. He worked with extraordinary intensity and concentration of mind on any subject that he chose and produced great effect on his contemporaries. As an example, I remember one of his last lectures on diamond when he expounded the idea of intensive search for diamonds in the Andhra State which stirred many to action. In the more tangible way he has left a tradition of study in a particular area of science. He and his students by continual effort have created an excellent tradition for the study of optics and spectroscopy. There is considerable degree of expertise in our country in this field. This should be cherished and allowed to increase in rapid measure. If it could be ensured, it will not only serve as a monument to Prof. Raman but will also be a service to the nation and to the cause of science.

SIR C. V. RAMAN AS A MAN OF SCIENCE AND HIS INTEREST IN GEOLOGY

L. RAMA RAO
Former Professor of Geology, University of Mysore

AMONG the leading savants who have held aloft the torch of science in India and added to its lustre by their own outstanding contributions, and enabled it to shed its light far beyond the confines of our country, the name of Sir C. V. Raman will ever occupy an honoured position. He belongs to that galaxy of scientists who appear on the scene, in the history of science, from time to time, and who are remarkable not only for their own direct contributions in their special subjects, but more so for enlarging the scope of their studies and opening out new lines of enquiry by their far-sighted vision and versatile outlook, thus leading to co-ordinated research in different directions so as to make our knowledge of science more complete and comprehensive. They stand out for all time as the beacon-lights which guide and illuminate these new pathways of science; and their greatness, far from being dimmed by the passage of time, actually grows as the years pass by, and we begin to recognise more and more fully the magnitude and importance of their fundamental contributions; and even long after they have disappeared from the scene, their memory will continue to serve as a perennial source of inspiration to the younger men.

Sir C. V. Raman was a specialist in Physics; but he was not the kind of scientist whose specialisation ultimately resulted in his knowing 'more and more about less and less' even in his own subject. He was one of the great master minds who maintained that all scientific endeavour should be to try and succeed in effacing the conventional lines which we often draw between subject and subject and thus 'compartmentalise' them. He firmly believed that all science is one and indivisible; and its ultimate objective should be to 'unite' and not 'divide' knowledge.

With his most versatile outlook, Dr. Raman developed, apart from physics, a keen attachment to all other branches of science, in several aspects of which he was greatly interested as a physicist. What attracted him to these other subjects was the opportunities they gave him to express his love and admiration of "Colours in Nature"—their origin and perception—in the fundamental understanding of which he was so involved as a man of science and which ultimately led him to his famous work on the "Physiology of Vision".

Sir Raman's contacts with geology started with his absorbing interest in the colours of minerals. He was struck by the endless variety in colour and lustre exhibited by minerals; and he soon set about making a thoroughly representative collection of these from all parts of the world, now seen as the most beautiful part of the Museum in the Raman Institute. 'Diamond' was the mineral which first attracted his attention by its many unique crystallographic and optical properties; and this became the subject of his very intensive research as a physicist for several years, resulting in the publication of several monographs of the greatest value and importance. He retained his interest in this mineral till the last, and had got together one of the best collections of 'natural diamonds'. He took a special interest in the geology of the diamond mines of India; and only a couple of years back he gave a most illuminating lecture on this subject.

Apart from the diamond, the other minerals which attracted his special attention were those which exhibited the most striking optical features like 'iridescence', 'fluorescence', 'opalascence', and 'play of colours'. He studied these phenomena as a physicist and offered new explanations for these optical effects. Sir Raman was always willing to address gatherings of geology students, and was a frequent 'lecturer' at the meetings of the Geological Society of the Central College, where his very presence was a source of inspiration to all of us.

Any geologist who, like the present writer, had opportunities of meeting Sir C. V. and talking to him intimately about recent developments in any aspect of geology,—as for instance, micropalaeontology which is so far removed from physics—was soon struck by his amazing capacity to follow all that you said with a clear insight into the nature of your problems; and he would soon follow up by putting a number of questions of a fundamental character in the concerned field which were most thought-provoking and immediately opened out an altogether new outlook in your approach.

Sir C. V. Raman was not merely a 'physicist'; he was a true 'scientist' in the widest and fullest sense of the term. He had an endless curiosity to probe into and unravel the mysteries of Nature in all their diversity and the results of his scientific work have therefore an enduring impact on all branches of science; and it is only natural that all scientists will remember him with the highest reverence, regard, affection and goodwill.

PROFESSOR RAMAN—THE ARTIST-SCIENTIST

G. N. RAMACHANDRAN
Indian Institute of Science, Bangalore
and
Department of Biophysics, University of Chicago

EARLY INTEREST IN MUSIC

If one were to summarise Professor Raman's life as a scholar, one would say that he was a scientist to the core. Science was the only thing that mattered to him and the pursuit of scientific enquiry was the one dominating impulse that led him through all his life. Even in science, Raman had always been fascinated by the beautiful part of it; beauty not only in the theory, but also in the objects and phenomena which he studied during his researches. It is not surprising that the earliest studies taken up by Raman were in the field of musical acoustics. Starting from the monumental work of Helmholtz, he devoted his time to the study of musical instruments, the quality of their tone and the theory of production of the musical tone by these instruments. His classical work on the theory of bowed strings is well known, and it is not at all surprising that the editors of the *Handbuch der Physik* chose Raman to write the article for them on "Musical Instruments and Their Tone" (1927).

MOLECULAR SCATTERING OF LIGHT

The study of acoustics is intimately connected with the study of vibrations and waves, and it is not surprising that Raman's interests passed from his early love for acoustics on to a life-long devotion to optics, the other great domain of classical wave mechanics. In fact, if one may talk of a unifying trend in the scientific work of Raman, it may be said to reside in the study of wave phenomena. His very first paper, which he published as a young student when he was a teen-ager, studying in the bachelor's degree class of his college, was devoted to the diffraction of light. In fact, diffraction is nothing but the result of the interaction of optical waves with material media, and this one aspect has dominated Raman's researches right from 1914 to the very end of his life. When he was called to take up the chair of Physics in Calcutta, he devoted his time immediately to the study of the diffraction of light by the molecules in a continuous medium, and came out with his first monograph on the "Molecular Diffraction of Light" in 1922. It was this interest in the interaction between light and matter that led him to study this subject in intimate detail during the decade of the 1920's, and which culminated in the celebrated discovery of the scattering (or diffraction) of light with change of frequency, which is known as the Raman Effect, in 1928.

PHOTON-PHONON INTERACTIONS

The fact that the diffraction of light by a continuous medium is associated with the existence in it of acoustical waves, traversing the medium in all possible directions, was also enunciated during the 1920's, and this phenomenon is known after the name of Leon Brillouin, the well-known French scientist. Raman was fascinated by this type of interaction between one wave and another and sought to establish the possibility of there being a change in frequency of the light wave as a result of its interaction with the thermal sound wave in the medium. During the 1930's, a number of papers appeared from the Raman School in Bangalore in which this change in frequency was demonstrated by interferometric methods.

At about the same time, Raman realised that the same theory which explains the scattering of light as the interaction between light waves and thermal sound waves, in which the sound waves are incoherent and are going in all directions, could also be developed to take care of the coherent diffraction of light waves by sound waves. This phenomenon was observed in Germany in the early 1930's with ultrasonics, and the mathematical and physical theory of it was published by Raman and Nath in a series of papers which covered the ground almost exhaustively. Raman and Nath were able to show not only the conditions for the maxima in the diffraction of light to occur (which were analogous to the familiar formulae in optics dealing with the diffraction by a series of slits or a grating, and the well-known phenomenon of the diffraction of X-rays by a crystal lattice), but also the distribution in intensity among the orders in the diffraction spectrum. The grating in this case is provided by the density stratifications induced by the sound waves, which produce a corrugated emergent wavefront.

COHERENT THERMAL SCATTERING OF X-RAYS

Both the Raman-Nath theory of ultrasonic diffraction of light and the observations on the hypersonic (Brillouin) scattering with change in frequency were made during 1934-37 and it is not surprising that Raman should have looked for an analogous phenomenon to occur in the diffraction of X-rays by crystals. As is well known, the usual diffraction of X-rays takes place from the periodic repetition of the molecular structure in the crystal in the form of a three-dimensional grating. Ideally, this leads to sharp "reflections" along specific directions given by the well-known Laue-Bragg conditions. However, if one considers that the static periodicity of the crystal is modified by a dynamic periodicity produced by the sound waves of thermal origin propagating through the medium (a phenomenon analogous to the Brillouin theory of scattering of light by media and the ultrasonic diffraction of light), then it is obvious that there should be intensity of X-rays diffracted in directions other than the Bragg maxima. Raman realised this and gave the correct description and formula for the direction of the non-lattice reflection of X-rays. He called it naturally the "dynamic reflection of X-rays", as this obviously arises from the existence of a dynamic periodicity induced by the thermal waves in addition to the static periodicity in the crystal structure. Raman and Nilakantan looked for the existence of such dynamic reflections and observed them in diamond and various other crystals. This discovery of the non-Bragg reflections in X-rays, made for the first time in Raman's laboratory in 1938-39, was confirmed by the work of several laboratories in other parts of the world almost simultaneously.

ANALOGY OF THE RAMAN EFFECT IN THERMAL SCATTERING OF X-RAYS

In his proposal of the theory of the dynamic reflection of X-rays, Raman emphasized the occurrence of a change in frequency of the X-rays in its interaction with the thermal waves. Raman, in fact, called it a "quantum" reflection, and the title of the first paper by Raman and Nilakantan on this subject is entitled "Reflection of X-rays with Change of Frequency" and has a section entitled "Analogy with the Compton Effect". Although the change in frequency is negligible and has not been experimentally demonstrated even now, the importance of the change in frequency along with the change in direction of the reflected wave cannot be overemphasized. In fact, it is the combination of both these types of measurements that has made the diffraction of thermal neutrons by acoustic thermal waves (a phenomenon closely analogous to the diffraction of X-rays by thermal waves, both X-rays and neutrons in these examples being about the same in wavelength) of such great practical interest. Although, at the time of Raman's discovery of the thermal diffraction of X-rays, the diffraction of neutrons had not been demonstrated, he was probably the one worker of that period who emphasized the change in frequency, which later has found such tremendous application in neutron diffraction for the understanding of the frequency spectrum of crystals.

Raman's associates extended the study of the thermal scattering of light to crystals during the 1940's and early 50's, and both the change in frequency and state of polarization of the scattered light were recorded directly on a Littrow spectrograph and compared with theory. In fact, they were even used to measure the elastic constants of cubic crystals like diamond at such high frequencies.

OPTICS, THE BEAUTIFUL

What has been stated above deals essentially with aspects of the fundamental physics of Raman's interests in the field of diffraction and its various manifestations. Simultaneously with all these studies, Raman had also been interested in the artistic aspects of diffraction and the beauties of Nature which are associated with diffraction effects. Starting from the classical work of Rayleigh on the scattering of light by the atmosphere and the explanation of the blue colour of the sky, Raman showed that the deep blue of the ocean is not a simple reflection of the blue of the sky, but that it arose essentially from the molecular diffraction of the sunlight by the water molecules in the ocean. Meteorological optics had always fascinated Raman and he made several investigations on the colours of halos and coronae and other such optical phenomena in the atmosphere. He showed that the colours of iridescent shells, of the plumage of certain birds and of the wings of butterflies are to a large extent due, not so much to intrinsic pigments, but rather to the phenomenon of diffraction. In fact, Raman's laboratory contains perhaps one of the best personal collections in the world of examples of such beautiful colour effects exhibited by natural objects of varied origin. This interest in colour, arising from interference, diffraction, or from other causes, has always fascinated Raman and one could never talk to him for a few minutes without his growing eloquent about the artistry of such phenomena, and his taking one to his museum and illustrating his talk by practical examples from his collection. It is not surprising, therefore, that, during the last years of his life, he devoted all his attention to the understandng of colour vision and spent a considerable amount of his time on the origin of colours of flowers.

THE BUBBLING SCIENTIST

I cannot but take this occasion to mention the fact that I owe all my early initiation into the mysteries of diffraction theory and Fourier transforms to Professor Raman. The very first problem which he gave me when I joined him as a student was on the interference effects produced by stratified layers, which led to a novel derivation of the classical Darwin formula in the dynamical theory of X-ray reflection by a perfect crystal, using a formulation for a finite number of stratifications proposed by Rayleigh before 1900. This was followed by a series of studies on the diffraction by spherical particles and particles of other shapes. In all these studies, Raman impressed on me the need to analyse any disturbance produced by the obstacle into their periodic Fourier wave components, which made a profound impression on me regarding the importance of the Fourier transform approach to the explanation of any phenomenon involving the interaction of waves with matter. In fact, in a series of lectures which Raman gave in Baroda on optics, during the time when I was a student of his, he systematically developed the use of such a plane-wave analysis for obtaining a simple picture of the optical phenomena occurring in various systems. Unfortunately, Raman could not complete the editing of the manuscript of the book based on his lectures during his lifetime, although they were delivered as early as the 1940's. In fact, he could never sit down to write anything systematically, because he was always bubbling with ideas, and was finding it necessary to make newer and newer studies in his research programme. In fact, if there is a message in Raman's life to our young scientists in India, it is that one should never give up thinking of new approaches in one's research. If I may put it humorously, it is better to have a wrong theory rather than to have no theory at all. If one ever met Raman and started talking science with him, one could not spend more than a few minutes before he came out with his pet theory of the moment—it might be on earthquakes, or cyclones, or the absorption spectra of anthocyanins. It is a pity that the enormous drive and energy that he had, combined with unbounded enthusiasm for the pursuit of pure knowledge, must have remained completely unutilised by the country for a number of years in his later life, for reasons which we need not enter here. But, if the younger generation would emulate the spirit of Raman and would follow in his footsteps in dedicating themselves to the service of Indian Science, it would be the best tribute that we can pay to the life and work of this great savant.

C. V. RAMAN THE UNIQUE MENTOR

N. K. PANIKKAR

Director, National Institute of Oceanography, Panaji, Goa

IN the realm of Indian Science, Professor Raman was the most outstanding figure for the last forty years. In making an assessment of his contributions to Indian Science, I have certain limitations. First of all, I was not privileged to have been his pupil. Secondly, the field of scientific research in which I have taken interest was far removed from the very many fields in which Raman was concerned. Nevertheless, it is not out of place to mention that I was privileged to know him for the past thirty years and during the last ten years or so, it was again my cherished experience to know him closely and to gain an insight into his attitude to science and problems facing India through intimate discussions during the several annual sessions of the Indian Academy of Sciences.

The first occasion I had of meeting Raman was during my research student days soon after the founding of the Indian Academy of Sciences in the year 1935. It was through the late Professor Gopala Aiyar that I had the occasion to meet him and the recollection of that meeting which I have to this day was the strong desire on his part to see that the best work done in India at that time by the young scientists was published in the *Proceedings of the Indian Academy of Sciences*. It is a matter of pride to me that some of my very early contributions were, in fact, published in the *Proceedings of the Academy* and this became a good tradition for many scientific papers which came from the Zoology Department of the University of Madras. When, even now, many scientists in India crave to have their papers published abroad, the keenness with which Raman was encouraging the publication of the work of Indian scientists within the country is well worthy of emulation at the present time. In spite of the fact that there were many difficulties in securing adequate circulation by publishing material in a then not very well-known journal, the support which he gave to the journal and the regularity with which it appeared, secured admiration from all scientific circles and there was a time when in many foreign libraries, the *Proceedings of the Indian Academy of Sciences* was the only Indian scientific journal known.

The next series of contacts I have had with him was after my return to India in 1942, after some years of work abroad. This was the time when he was vigorously pursuing problems of optical physics at the Indian Institute of Science, Bangalore, after he had relinquished the Directorship to take independent charge of the Department of Physics. I still remember the long discussion I had with him one afternoon on the role of physical and biological research in Indian science.

For many years, Raman's attitude towards biological sciences was that they did not belong to the forefront of scientific research. He was inclined to consider that biologists in general lost sight of the main problems through too much attention to descriptive aspects and too little attention to original thinking. He felt strongly that the fundamental discoveries in the field of science have to emanate from the physical sciences. This somewhat rigid earlier approach had mellowed in later years and he openly admitted that there was a growing realization on his part that biological sciences and the contributions therefrom are equally of the highest value in the advancement of science. As a corrective to his earlier attitude he used to allude to his earlier interests in biological topics such as iridescence of shells, the colour of birds and butterflies, and lastly, to the colour patterns in flowers. The latter subject led him to the studies on the physiology of colour vision on which he spent much time during his last years and controversial although some of his concepts, he brought to bear on these studies a refreshing originality and attempted at finding solutions to the basic problems.

Great as his achievements were, he was humble about what has already been accomplished by him and he openly admitted at a gathering of Fellows of the Academy assembled to celebrate his eightieth birthday that he considered his life as a failure. This was because of the high standards he had set for himself and he explained that his assessment was based on the achievements of eminent scientists of the calibre of Helmholtz and Rutherford.

His earlier consideration that biological sciences do not rank as high as physical sciences did not at any time prevent his intense enthusiasm to promote work in biological fields. Even in subjects which he himself considered as not of high importance, it was his endeavour to do his best to see that the results of studies undertaken are quickly published in India, so that the younger generation of scientists will have the fullest opportunity to have their papers seen by their compeers in all countries. In this respect, he abhorred the approach of certain perfectionists who would never like to see material published unless it had reached a form in which all work was completed. But in his own field of research he applied the test of perfectionism rather rigidly; to many of his later students, his standards were high and exacting.

Looking at the background in which Raman worked, and the milieu of Indian science during the past several years, the most outstanding contribution he made has been the building up of the Indian Academy of Sciences and the Raman Research Institute. His contributions in the field of physics have, no doubt, been of outstanding significance and are dealt with by many other contributors in this volume, who are most competent to assess them; but to one who is not a physical scientist, the assessment of his towering personality in Indian Science has been one of giving new inspiration and confidence to the large body of scientists who were associated with him, irrespective of their disciplines. The Annual Sessions of the Academy witnessed small gatherings of persons deeply interested in science, who met to discuss problems with which they were concerned, and in which they were contributors and which they wanted to foster by mutual exchange of ideas and criticism. These annual gatherings drew perpetual inspiration from him and as one who belonged to the many group discussions which he organized under the aegis of the Academy, I feel that his impact on this body of workers has been profound.

As an exponent of science to the public and the layman, there were very few in the world of science to match Raman. In the popular lectures he delivered during the Academy meetings and which he arranged during the sessions, attempts were made to cover various growing points of Indian Science. This by itself has been a great education to the Indian scientific community. He took great care to select University centres for holding the Annual Sessions of the Academy and arranged programmes in a very compact and effective manner, with a good admixture of original contributions, reviews and popular lectures. The size of the meetings was always kept small except for popular lectures. It was the generally accepted rule that scientists from all disciplines attend the whole series of meetings and lectures. Many of us remember the great care with which he selected topics for group discussions, arranged the speakers, allotted time to them and provided opportunities for general discussions in which he himself took part. To many of us with heavy administrative and organizational duties, the Academy Sessions provided a much-needed intellectual enchantment which kept us as scientists. In this manner, in addition to his great drive and enthusiasm as leader of Indian Science, he acted as a great dispenser of the highest scientific traditions, giving lustre to the group of dedicated workers he fostered and the institutions where these meetings were held.

Raman held the English language in the highest esteem as the most effective vehicle for the propagation of scientific ideas and was firmly of the view that the growth and achievements of Indian science was inextricably connected with the continued usage of this world-medium of communication.

The blue colour of the oceans was one of the subjects which attracted him early in life and came for study at the hands of Raman and K. R. Ramanathan many years ago. He was deeply interested in the growth of oceanographic studies in India and felt happy that schools on certain aspects of ocean research were coming up in India. "The country must have several ships for these studies," he used to say, "and not rely on the one you borrow from the Navy." Speaking after my account of Indian ocean researches on one occasion at Poona, he unhesitatingly attributed the loss of Indian independence in the days of colonial expansion to the neglect of the seas and called for renewed scientific effort in this field. "The colour of the sea interests me more than its fishes," he used to tell me; he had desired some new and original approach to optical problems in oceanography to be taken up by Indian physicists.

At the Raman Research Institute which he founded, it was his ambition that all branches of work should develop and flourish, physical, chemical, biological and geological. The full fruition of his ideas in this direction had not taken place owing to the enormity of the financial resources required and the exacting standards of scholarship which he demanded from the younger generation of scientists who joined him. Perhaps the environment in which such all-round development could have taken place had not progressed to that desired level to give effect to the lofty ideals which Raman held. Let us hope that many of us who have gained from his inspiring leadership and association with him will live to see his noble ideals kept alive and the high aspirations which he had held out for the Institute, achieved.

RAMAN AND ASTRONOMY

M. K. V. BAPPU
Director, Indian Institute of Astrophysics, Kodaikanal

MANY a great man of science, whose personal contributions have led to the unravelling of some of Nature's secrets, has been an ardent admirer of Nature's handiwork and its beauty. Raman belonged to this restricted fold, whose members gained inspiration from the beauty of their surroundings. The blue of the ocean, the plumage of birds, floral colours and the symmetry of crystals gave him a feeling of intense rapture, and the inspiration to ponder over their origins and characteristics. Likewise, the canopy of stars as seen on a clear moonless night must have stirred the imagination of one who was so much impressed by natural splendour. Indeed, in one of his writings he has described astronomy as "a heaven-born river of knowledge which flows to the earth and fertilizes the fields of learning and culture".

For one who had such an intense feeling towards the splendours of the science of astronomy, Raman's personal involvement in its development has been only from the side lines. One may consider this surprising. An explanation would be the limitation imposed on an individual's selection of a sphere of effort, by the brevity of the human life-span. Raman has often said that should he be given the opportunity of living his life all over again, he would choose to be an astronomer. This statement is expressive of his interest and the fascination that the subject had for him.

As one whose principal researches lay in the science of optics, Raman admired the contributions of the large aperture telescope to astronomical progress. He believed that "progress in astronomical science in a country depends on the existence in it of skilled opticians who can grind, polish and figure great lenses and mirrors up to the most exacting requirements". These words appraise the situation with as much correctness today, as they did three decades ago when he expressed them. A great admirer of John Brashear, the famous American telescope builder, he felt that the immense support which American men of wealth gave astronomy in their country, was to a large extent the offshoot of Brashear's telescope building capabilities and his love of the stars. Like the connoisseur of art, he delighted in the sheer artistry and precision of a well-figured mirror. He was happy to possess a few of the mirrors made by one of his contemporaries, H. P. Waran. And he derived the satisfaction of a dream-come-true as it were, when he learnt that Jayarajan at Kodaikanal had been successful in figuring larger mirrors for astronomical use, and that we had embarked on a large scale telescope-building programme.

Raman was a Visiting Professor at the California Institute of Technology in Pasadena, for a few months in 1924. These were stirring times in astronomical history and must have left a lasting impression in his mind. The Hale era at Mount Wilson was at its peak where the great 100-inch telescope had just gone into operation, and in the hands of Hubble had almost as a first result yielded the spectacular transformation of our concepts of distances in the Universe. Raman recounted these momentous days often; the sights of the gaseous nebulosities that he viewed through the 100-inch had etched in his memory a picture of inspiration and beauty. Years later, I had an account of his first visit to Mount Wilson from J. A. Anderson of diffraction grating fame, who had given Raman his guided tour. Raman spent a couple of nights on the mountain taking in the heavenly sights at night and exploring the mountain side during the daytime. Anderson also recalled how Raman took his companions by surprise, walking barefoot over the various trails on the mountain, in preference to the foot-gear his comrades of the enterprise considered necessary.

Raman had been very vociferous in his plea for strengthening research effort in astronomy in this country. Writing in *Current Science* in 1943, he considered that "the organization of scientific research in India must be considered radically defective unless and until adequate provision is made for astronomical study and research of the highest grade in the country". This stems from the conviction that the universe is a vast physical laboratory providing an infinite variety of experience. The results of observational astronomy have really been the nucleus of current physical thought and the interaction between physics and astronomy has been to mutual advantage. In our age of space consciousness, astronomy has regained its importance in providing the framework of scientific culture and associated technology that is meaningful to human welfare and progress. In a country with a rich cultural heritage of the past, and where the desire to seek a meaningful future through the methods of science prevails, science planners would do well to pay heed to Raman's words on the need of an invigorating climate of observational astronomy. Recent developments in the country, in the form of support to the astronomical cause, augur well for the future. Poised as we are on such a threshold, let us hope that the contributions of the Indian astronomical community will, in the years to come, be such as to bear out Raman's convictions on the role of astronomy in his country's welfare.

PROFESSOR RAMAN'S INTEREST IN METEOROLOGY

P. R. KRISHNA RAO

Retired Director-General of Observatories

I DID not have the good fortune to be a student of Sir C. V. Raman. Although I had met him and talked with him a few times in 1947, 1951 and 1961, I came in fairly close contact with him only in 1964 when he asked me to organise a symposium on Meteorology at the Annual Meeting of the Indian Academy of Sciences at Poona in December 1964 and made me preside over the symposium. At that symposium, he asked several questions regarding the cause of "jet streams" in the atmosphere. He thought that the jet stream was an important global phenomenon of which there ought to be a simple explanation.

I came in closer contact with him since December 1965, after I had retired from service and settled down in Bangalore, when he nominated me to be a member of the Council of the Indian Academy of Sciences in a vacancy that had just then occurred. In the five years prior to his passing away, we met a number of times when he discussed with me problems of meteorology, specially those concerning the general circulation of the atmosphere and jet streams, sometimes for an hour or two at a stretch. He did me the honour of visiting me at my residence several times for borrowing books on meteorology or for discussing meteorological problems engaging his attention. I believe he appreciated expression of frank and forthright views by me on some of his views on jet streams and the general circulation of the atmosphere.

He spoke on Weather and Atmospheric circulation at the Raman Research Institute as Gandhi Memorial Lecture on 2nd October 1967, and published an article on "Zonal Winds and Jet Streams in the Atmosphere" in the issue of *Current Science*, dated 20th November 1967. He also spoke before the Aeronautical Society of India, Bangalore Branch, on the same subject. It was also the theme of his Presidential Address at the Annual Session of the Indian Academy of Sciences at Madras on 19th December 1967. A summary of this address appeared as an article in the *Current Science*, dated 20th March 1968.

Sir Raman's main thesis was that the jet streams are phenomena directly connected with the rotation of the earth and but for the rotation of the earth, they would not exist. He explained this in a simple manner as in his article in *Current Science* of 20th March 1968, and said that "a clear understanding of the manner in which the rotation of the globe influences its gaseous envelope is of the utmost importance in the present context". I had occasion to mention to him that the effect of the rotation of the earth on atmospheric circulation had been realised and studied since the times of Hadley and Helmholtz and that Rossby and Defant's "mixing theory" of jet stream formation is based on the good agreement they found between the theoretically calculated meridional profile of zonal wind speed at constant absolute vorticity and constant angular momentum (which is dependent on the latitudinal variation of the speed of rotation of the earth) and the observed mean geostrophic wind profiles.

Sir Raman had a unique capacity to examine a problem *de novo* in a fundamental way. He examined meteorological problems as a classical physicist and not as a meteorologist with preconceived ideas. His interest in meteorology started perhaps with his interest in atmospheric optical and acoustic phenomena in the early years. He mentioned once or twice that the high wind speeds in jet streams may have some influence on the scintillation of stars. Apart from jet streams and the general circulation of the atmosphere, he was much interested in the Indian south-west monsoon and in medium and long-range forecasting of the strength of the monsoon for the benefit of Indian agriculture. He was convinced that the tropics, specially "the equatorial belt on the surface of the earth, plays a highly important role in terrestrial meteorology" and that tropical meteorologists, specially Indian meteorologists, had a duty to show, by their researches, in what way the tropics and tropical convection controlled and contributed to the general circulation of the atmosphere and the monsoons. He mentioned to me once or twice that he would welcome study of one or two important tropical meteorological problems being undertaken at the Raman Research Institute.

Sir Raman knew the India Meteorological Department for over 50 years since the time of Sir Gilbert Walker. A number of his students became meteorologists and have played, and are playing, an important part in the development of Indian Meteorology. He asked one of them to give a talk on "Modern Developments in Meteorology" at the last Annual Session of the Indian Academy of Sciences held at Bangalore in September 1970, two months before his death.

It would be a tribute to the memory of Sir C. V. Raman if Indian meteorologists play an active part in researches on tropical meteorology, specially on the Indian monsoon, and make contributions of lasting value to meteorology and to India.

SIR C. V. RAMAN AS A METEOROLOGIST

Dr. C. Ramaswamy
Formerly Director-General of Observatories, New Delhi

Introduction

The intellectual greatness of Sir C. V. Raman was seen at its best in his passion for knowledge and his remarkable ability to go into the fundamentals of any subject in which he felt interested. His sense of curiosity would never be satisfied until he felt that he had found a convincing explanation for any scientific phenomenon which came within his purview. In this regard, meteorology was no exception to him. During the last two decades of his hectic activities, he evinced a great deal of interest in meteorology. His example inspired scores of Indian meteorologists and made them realise that, quite apart from the services which they rendered to various institutions during their professional work, it was their duty to contribute also to basic research in meteorology.

Symposia and Lectures on Meteorology

Prof. Raman organised many symposia and lectures on various aspects of meteorology. In the Annual Session of the Indian Academy of Sciences held at Delhi in December 1951, he convened a symposium on the *Physics of Thunderstorms*. Raman's wide interest even in this field may be seen in the fact that the subjects discussed in the symposium included, among others, electrical aspects of thunderstorms and their bearing on the structure of aircraft. During the International Indian Ocean Expedition in 1962, Prof. Raman organised at Bombay, a symposium on *Oceanographic Research*, in which leading oceanographers and meteorologists participated. This was followed in December 1964 by a symposium on *Meteorology*, at Poona. The main purpose of holding this symposium was that Poona was the second most important centre for meteorological activities in India and Raman felt that this opportunity should not be missed for getting together as many meteorologists as possible and giving an impetus to the development of meteorology. These are only a few examples to show Sir C. V. Raman's interest in the science of meteorology and his ardent desire to make this "infant science" grow fast on the Indian soil.

JET STREAMS IN UPPER AIR

In the Annual Session of the Indian Acadamy of Sciences held at Waltair in December 1956, the present writer, at the suggestion of Prof. Raman gave a talk on "Jet Streams in Upper Air". The absorbing interest with which Prof. Raman followed the lecture will ever remain fresh in the memory of the present writer. From that time onward, Prof. Raman became interested in the phenomenon of jet streams. During the symposium on meteorology held at Poona in December 1964, he himself raised the question of the origin of jet streams. He was not satisfied with the explanations given by the meteorologists present at the symposium and he expressed his deep conviction that the problem will have to be tackled afresh from fundamentals.

THE ATMOSPHERE OF THE EARTH

Prof. Raman subsequently gave expression to his own ideas about the origin of the jet streams and about the general circulation of the atmosphere in two scientific papers.[1,2] The second of the two papers is entitled, "The Atmosphere of the Earth". We shall confine our attention to this paper as it contains his later views on this subject.

Raman starts with a number of basic concepts each of which is already known but which have been brought together by him for the first time. The basic concepts are:

(*i*) The maximum speed of movement of the ground is at the equator. The speed decreases as we proceed poleward and becomes zero at the poles.

(*ii*) The equatorial belt 30° N to 30° S receives the maximum amount of solar radiation in all seasons of the year. The insolation over the belt 30° to 60° (north and south) is notably less than that over the equatorial belt. It also shows large differences as between summer and winter months. In the belt 60° to 90° (north and south), the insolation is much less than in the equatorial and middle latitude belts. It shows, in addition, large variations with the seasons of the year.

(*iii*) Frictional forces affect the behaviour of the atmosphere, in the mean, only upto about 600 meters above the *ground.*

(*iv*) Momentum from the rotating earth is transported vertically to the upper levels of the atmosphere, quickly and efficiently by parcels of air continuously going up as a result of heating near the surface of the earth by solar radiation. This would be most pronounced and would be a constant feature throughout the year between 10° N and 10° S.

To the above basic concepts, Raman adds the postulate that the uprising air parcels would drift horizontally from the level where their updrift speed would become zero.

On the basis of the above, Raman explains:

(*a*) The existence of the mean westerly jet streams in the upper troposphere near 30° N and 30° S.

(*b*) The prevailing westerly zonal winds in middle latitudes extending from high levels *downward* upto the ground.

(*c*) Easterly surface winds in the equatorial regions and near the poles at ground level.

(*d*) Westerly winds with considerable speed over the polar areas at high levels.

The reader will undoubtedly concede that the broad features of the general circulation including the mean westerly jet stream have been explained by Raman. The sophisticated meteorologist may, however, feel that Raman has rather over-simplified the problem. For instance, he has not taken into account the important contribution to the general circulation by orography.[3]

It is of interest to mention that Prof. Raman's great emphasis on the vertical transport of momentum by convectional processes is quite consistent with recent findings of dynamical meteorologists[4,5] from entirely different considerations that convective processes are of great importance and have to be taken into account in the simulation of the general circulation of the atmosphere by numerical models.

CONCLUSION

What, however, impresses the professional meteorologist most in Raman's paper is his remarkable freshness and simplicity of approach. For instance, he starts from the school-boy's concept of the rotating earth and ends with the most important results in modern meteorology in a paper which does not cover even seven pages. And it will also be remembered that Raman wrote meteorological research papers for the first time when he was 80 years of age. This outstanding fact of Raman's life will undoubtedly be a source of inspiration to meteorologists in this country for generations to come.

1. Raman, C. V., *Proc. Ind. Acad. Sci.*, 1967, 66 A (5), 241.
2. —, *Ibid.*, 1968, 67 A, p. 123.
3. Reiter, R., Elmar, *Jet Stream Meteorology*, Univ. Chicago Press, 1963, p. 384.
4. Manable, S., Smagorinsky, J. and Strickler, R. F., *Mon. Weather Rev.*, 1965, 93, (12), 769.
5. Arakawa, A., Katayama, A. and Mintz, Y., *Proc. WMO/IUGG Symp.*, Tokyo, 1968, Num. Weather Prediction, IV–7, 8.

PROFESSOR SIR C. V. RAMAN AS I KNEW HIM

R. ANANTHAKRISHNAN

Institute of Tropical Meteorology, Poona

THE scientific genius of Professor Sir C. V. Raman began to blossom at the age of 16 or 17 while he was still a student at the Presidency College, Madras, and his passion for science continued unabated till the time of his passing away at the age of 82. For over six decades, he dominated Indian Science and inspired generations of scientists who loved, admired and revered him. He won the highest honours, laurels, distinctions and awards, both national and international, for his researches and discoveries. His life is truly a saga of science. With his versatility and penetrating intellect, he combined child-like simplicity and deep humanity which endeared him to all those who came in contact with him. It is difficult to write about him and the many facets of his personality without getting the feeling that one has not adequately expressed what one wishes to convey.

In 1933—five years after the discovery of the Raman Effect and three years after he was awarded the Nobel Prize—Prof. Raman moved from Calcutta to join the Indian Institute of Science at Bangalore. In the newly-created Department of Physics at the Institute he pursued his scientific activities for a period of 15 years. I was one among the first batch of 8 or 10 students, fresh from the university, who joined to work under him in August 1933 and I was associated with him for the next four years. Anyone who wished to work under Professor as a regular student had to undergo a searching oral examination in which the candidate's knowledge of fundamentals and capacity for original thinking would be severely tested. Although Professor attached importance to academic records, he always made his own assessment of a student.

Once having been selected, the students felt at ease with Professor. He was kind, generous and large-hearted. He had his own way of developing self-confidence and self-reliance in his students. He would treat them as his equals while discussing scientific matters. It was his habit to go round the laboratory every morning meeting each student, discussing the progress of his work and often suggesting new ideas. He would give free expression to his joy when a new result was brought to his notice. In his public lectures, he would refer to his students by name and talk about their work. All this was a thrilling experience to young students and a powerful incentive for sustained hard work and endeavour. A unique rapport was thus established between Professor and his students.

Professor encouraged his students to develop capacity for clear talk and exposition. He often remarked that one should be able to think on one's feet. His talks and lectures were always scintillating with new ideas and fresh outlook. The concept of the corrugated wave-front which is the basis of the famous Raman-Nath theory of the diffraction of light by ultrasonic waves came to him in a flash of intuition in the course of a talk.

Professor deprecated blind imitation and repetition of the ideas of others. "Let us think and do something original instead of browsing in Prof. Debye's backyard" was his characteristic remark on an occasion when someone was presenting the results of his study on the dielectric constants of liquids.

My work under Professor was concerned with the molecular scattering of light and the Raman Effect. He was still very much interested in problems relating to classical scattering of light, interest in which had somewhat waned with the discovery of the Raman Effect and the vast new vistas of research it opened up. I began my work on Raman Effect by photographing the Raman Spectrum of a small sample of heavy water which had been presented to Professor from Norway. He was delighted to see the spectrum and the large frequency shift of the vibration bands as compared with those of ordinary water.

Professor recognised that quick publication of results was an essential part of scientific research. This was a great stimulus to young workers. He was free and generous with his ideas and would himself correct and revise manuscripts of papers which his students took to him. *The Proceedings of the Indian Academy of Sciences* constituted the forum for most of the publications from Professor's laboratory.

The range of Professor's scientific interests was amazing. He had working under him at the same time students of physics, mathematics, physical chemistry, organic and inorganic chemistry and even geology, all of whom received his direction and guidance on the problems on which they were working. Scattering of light and the Raman Effect, colloid optics, theory of molecular vibrations, experimental and theoretical studies on the diffraction of light by acoustic waves of ultrasonic and hypersonic frequencies, electrical and magnetic anisotropy of substances, X-ray diffraction by crystals and liquids, structure and properties of diamond, vibration of membranes, origin of the colours of shells and plumage of birds were among the topics on which studies were being pursued by Professor and his students during my stay with him, leading to a large stream of research papers.

Generations of students have passed through the portals of Professor Raman's laboratories inspired by the radiance of his genius and scintillating personality and carrying with them far and wide his message of science and zeal for scientific research which they have tried to spread around them. This is one of his greatest contributions to Indian Science apart from his own great discoveries and contributions which rank him among the immortals of science.

SIR C. V. RAMAN AS A TEACHER AT BANGALORE

P. R. PISHAROTY
Physical Research Laboratory, Ahmedabad-9

PROFESSOR Chandrasekhara Venkata Raman has been a great *Acharya* and I have been extremely fortunate in having been one of his students. His investigations on the colour of the sea and on the Indian musical instruments were text-book material during my student days. The "Raman Effect" was discovered by him at Calcutta in 1928, a few months after I had joined the Physics Honours course at Tiruchirapally and an essay on "Raman Effect" was one of the expected questions for our final examinations in 1930. It was in that year that Prof. Raman received the Nobel Prize for his discovery of new radiations in the light scattered from several kinds of substances. But these did not bring me into direct contact with the great *Acharya*.

In 1933, Professor Raman left Calcutta for Bangalore on appointment as Director and Professor of Physics at the Indian Institute of Science. Although some of my college-mates joined the Bangalore Institute as full-time research scholars in 1934, I could not do so. However, in 1935, I learnt that Professor Raman would permit employed science teachers to work under his guidance during their vacations. Luckily, I applied for and was promptly granted that privilege. It changed my life and career. Thereafter, for several years, I was a "vacation worker" at the Institute and derived encouragement, inspiration and scientific insights from the great *Acharya*.

My first meeting with Professor Raman has been a memorable event. I was called in while he was busy dealing with urgent administrative matters brought in by the Registrar of the Institute. He asked me to be seated, and allowed me to watch his quick decisions. In between, he told the Registrar how happy he was to have me as a student, for whom he need not take up the dual responsibility of providing a scholarship then and a job later.

In a few minutes he disposed of the Registrar's problems, and took me to his research desk. He gave me a seat and questioned me in physics and found out that my familiarity with microscopy, scientific photography and similar laboratory techniques was poor. He encouraged me by saying that I need not worry about my inexperience in them and that I would be able to acquire the necessary proficiency in them in a couple of days. He next suggested a scientific problem involving high magnification microscopes and microphotography for my study, and gave a German monograph to get acquainted with the background knowledge necessary for the study. With one piercing look, he found out that I knew no German. He said: "Don't be afraid. This article (100 pages) will not contain more than 500 scientific words; you can translate the whole thing in two days using a dictionary; you will see that half the material consists of equations." Thus, in less than half-an-hour, he had shown me the microscope and how to operate it, what to look for, the literature necessary, and more than all that provided great encouragement.

For about three weeks thereafter, he was not at Bangalore; when he met me later, he wanted me to show him what I had done in the meantime. When I showed him what I had done, he got very enthusiastic about it, and went through what I had written, line by line, suggesting corrections and improvements. Thereafter, I had to show him every morning what I had done the previous day. There was no compulsion whatsoever. We regarded it to be a privilege to be with him and watch him correct or modify the words, explaining the why of every correction or modification.

Professor Raman was at his desk at 6 a.m. every day. Till about 9 a.m. he would be there scrutinising the work done by his students, or going round the laboratory. During these visits he would offer his suggestions for improvement in the experimental set-up, in the analysis of data or in the mathematical solution of problems, as the situation demanded. He had a prodigious memory regarding all the scientific material which had appeared in print in the English and German periodicals or books. He would go home for a quick breakfast at about 9 a.m., and would be back in his Director's Office by about 10 a.m. Twice or thrice a week there would be seminars, where one of the students would report the work that he had been doing, experimental or theoretical, the difficulties encountered by him, the results obtained, etc. During these seminars, Professor Raman would think aloud and one could see and hear his intellectual brilliance and get illumined and inspired. These seminars were superb intellectual treats to all present. The student speaker as well as the other students received from Professor Raman numerous ideas for their investigational work listening to these seminars. In the evening, after discharging the onerous responsibilities of the Director, he would be back at his research desk at the service of his students, or digging away at his own research work, almost till 8.30 p.m. every day. Occasionally, he would go out for a drive in the evening and would usually take along with him one of his students whom he could locate in the laboratory as he was leaving. His students felt that their work should begin at least at 7 a.m. and continue at least till 10 p.m. every day, with brief breaks only for their lunch and dinner. If any one came to the laboratory after 7 a.m., he would miss the opportunity of having any long discussion with Professor Raman, for some other student would have taken up that opportunity.

Whenever you entered the Professor's room, you came out a wiser man. One day I heard a student telling him: "Sir, I feel that this is so." His remark was: "My dear young man, physics is not philosophy; your feelings have no value unless you prove them." On another occasion a student showed a spectrogram, depicting the results of his work for a week or more. Prof. Raman remarked somewhat like this: "Wonderful. The lines have come out beautifully." After some more examination of the plate, he took out his pocket-lens scrutinised it again, and said: "These two lines could be better. Perhaps a longer exposure is necessary. I am sure you can get a better spectrogram if you try again. I would advise you to do that. The spectrograph has to be focussed better. You see, this spectrogram is no good." Each sentence was spoken two minutes after the previous one. His initial encouragement so much boosted up the morale of the student, that he could willingly subject himself to all that hard work again and again.

On one occasion I was feeling a bit depressed while carrying out an experiment with an X-ray apparatus at the Institute. Professor came in at about 7 a.m. and noticed my mood. He asked me the cause of my depression. I replied that a distinguished scientist in the United Kingdom, was working on the same problem as myself and that he had a 5 KW X-ray tube at his disposal. He asked me the power of my X-ray tube. "1 KW, Sir." He said: "That is all; there is a very simple solution; put a 10 KW brain on the problem," smiled and moved off. He meant what he said. He had supreme self-confidence;

and more than that he generated it in his students. Time in and time out, he would show by precept and example, that Ambition, Endeavour and Courage are the three qualities essential for good scientific work.

Only his students know his humanism. He would lend full support to the work carried out by his students. Any criticism of that work, he would answer with all his might. He was anxious that all the credit for the work should go to the students. As far as he was concerned, he had guided the student so completely, looked through every word of the final published paper, revised it five or six times sitting with the student, so that any distinction between his work and the student's work had ceased to exist. He would follow the career of his students even after they had taken up jobs elsewhere. They could always count on his support. I was often reminded of Vallathol's poem, "Student and Son". As with Lord Siva, the student took precedence over the son, in the case of Professor Raman also.

While I was leaving the Institute for a job in the India Meteorological Department, he gave me the following advice:

1. Do you know the secret of keeping good health ? It is keeping yourself warmer than what is necessary.
2. Since you are going to earn your livelihood through scientific work, never grudge buying books. You will find an investment in books and journals very rewarding.

I hope that I have indicated his method of guiding students. He inculcated in them a capacity for long hours of work and a self-confidence that they can and should pit their brains against the best brains of the world. Under his magnetic personality, these qualities lasted at least as long as the students were with him ; but alas, many of them lost these qualities soon after they moved away from his proximity. However, whenever any of them went to him, he re-generated those qualities in them through a few minutes of conversation.

An *Acharya* of the stature of Professor Raman is rare in any country at any time. His intellectual brilliance was something unique. His brain was equal to that of three or four Nobel Laureates put together. It was a God-given gift. However, he had many qualities, which can be emulated with some effort. I have tried to recount some of the imitable qualities of Professor Chandrasekhara Venkata Raman, which, if emulated by teachers, will be rewarding to our nation, which is struggling under a "poverty-culture"—financial and intellectual.

PROFESSOR C. V. RAMAN AND THE COLOUR OF THE SEA

L. A. RAMDAS

Emeritus Scientist, National Physical Laboratory, New Delhi

1. Introduction

I HAVE selected this topic for two reasons. Firstly, Prof. Raman ushered in a new era of important research at Calcutta with his classical paper "On the Molecular Scattering of Light in Water and the Colour of the Sea" (*Proc. Roy. Soc.*, Sec. A, Vol. 101, 1922). Secondly, I had the privilege of assisting him in the urgent laboratory experiments at Calcutta which have been discussed in this very first paper by him on the topic referred to above.

The blue colour of the sea is a vast and beautiful phenomenon that sea-faring folk must have seen and admired from the earliest times. An intense love of Nature and the colourful beauties of natural phenomena was a very prominent trait of Prof. Raman's character and the deep blue of the Mediterranean Sea naturally attracted his scientific interest while he was crossing it during his return voyage to India after his first visit to Europe in 1921.

Lord Rayleigh who had so successfully explained the blue colour of the sky as due to the scattering of sunlight by the molecules constituting the gaseous atmosphere, when he discussed the colour of the sea had stated that *"the much-admired dark blue of the deep sea has nothing to do with the colour of water, but is simply the blue of the sky seen by reflection"*.* Prof. Raman would not accept the above conclusion of Lord Rayleigh. He intuitively felt that the matter needed a fresh critical examination. Out in the open sea, the conditions are complicated by many variations due to the state of the sky, the state of the sea surface and the inclination of the solar rays. Nevertheless, to a keen mind like Professor Raman's, careful observation with the simplest of equipment, *viz.*, the eye aided by a Nicol prism, revealed the important fact that like the sky the ocean also is blue by virtue of its own capacity to diffract or scatter some of the incident solar radiation. To cite just one of his findings during this voyage, when he quenched the reflection on the sea surface of that part of the sky blue which was incident on the sea surface and reflected towards the observer at the Brewsterian angle, and so got rid of the reflection of the sky, he found the deep sea glowing with a deeper blue than that of the sky, evidently due to the scattering by the molecules of water constituting the sea. These and many other interesting observations made by him during the voyage convinced him that Lord Rayleigh's explanation was not altogether correct. Prof. Raman returned to Calcutta in September 1921 full of excitement and enthusiasm to test out his ideas under the controlled conditions of the laboratory by crucial but simple experiments, before publishing his results. Without the loss of a single hour he embarked on these experiments. The present writer had the unique privilege of watching his genius at work and of assisting him in this investigation. Instead of wasting valuable time in preparing vacuum-distilled pure samples of water (this was done in the immediately following investigations a few months later), Prof. Raman decided to examine readily available samples of water contained in carefully selected cleaned perfumery bottles of cut glass with uniform sides and square shape. An intense beam of light, about half-a-centimetre cross-section, was passed centrally through the water sample and its track observed in the transverse direction. A dark background was secured by coating the back of the bottle with dull black paint. Against this background it was easy to observe the intensity of the scattering by the water. Starting with tap-water which showed an intense whitish track with many motes and dust particles, attempts were made to precipitate the suspended matter by gelatinous precipitation rather unsuccessfully and it was not until we discovered some large bottles of distilled water lying stored away for many months if not years that the feeblest intensity of scattering could be found. The water from these bottles was carefully siphoned into the experimental containers and the track of scattered light became feebler on allowing time for any residual particles to settle. The track was then extremely feeble and of the azure colour of the sea. The intensity of scattering was compared with a rotating photometer with the blue track in saturated ether vapour. The comparative scattering of ether vapour and dust-free air had been studied by the younger Lord Rayleigh. It was soon estimated that the intensity of molecular scattering by liquid water was about 175 times that in dust-free air.

---

* See *Rayleigh's Scientific Papers,* Dover Publications, Inc., New York, Vol. 5, p. 540.

2. THE EINSTEIN-SMOLUCHOWSKI FORMULA FOR SCATTERING BY LIQUIDS AT THEIR CRITICAL STATE

By this time, Prof. Raman was convinced that the molecular scattering in liquid water was very much smaller than that indicated by the simple Rayleigh law of scattering where the individual molecules are assumed to be independent scattering centres owing to the large intermolecular distances. With characteristic, unerring intuition, Prof. Raman invoked the expression worked out earlier by Einstein and Smoluchowski, based on the theory of fluctuations to explain the very intense scattering of light by a liquid under the special conditions prevailing at the critical temperature. He felt sure that the same formula should hold good at all temperatures of the liquid state. The Einstein-Smoluchowski formula for the transverse scattering by the liquid at its critical temperature is:

$$\frac{\pi^2}{18} \cdot \frac{\beta}{\lambda^4} \cdot \frac{\mathrm{RT}}{\mathrm{N}} \cdot (\mu^2 - 1)^2 \times (\mu^2 + 1)^2$$

where λ is the wavelength, β is the compressibility of the substance, μ its refractive index and R, T, N have the usual significance attached to them in the kinetic theory. In the case of gases β is simply the reciprocal of the pressure and μ being nearly unity, the above expression reduces to the Rayleigh formula. Computing the intensity of the scattering by water in the liquid state according to the E.S. formula stated above, Prof. Raman showed that water at 30° C should scatter 159 times as strongly as dust-free air under standard conditions. This is of the same order of magnitude as the experimental estimate referred to above. It may be stressed that excepting for a modest correction to account for the anisotropy of the molecule, the E.S. formula has stood the test of time, in accounting for the intensity of scattering by liquids at all temperatures : a tribute to Prof. Raman's intuition in 1921.

3. WHY THE SEA HAS A DEEPER BLUE THAN THE SKY ?

Prof. Raman estimated from the above intensity ratio of 160 in round figures, that a layer of water 50 metres deep would scatter approximately as much light as 8 kilometres of the homogeneous atmosphere. For the case where the vertical sun is illuminating the sea, the upward scattering will be twice the transverse value B. If γ is the coefficient of absorption of light in water, the observed intensity of scattering from the deep sea will be :

$$\frac{2B}{\lambda^4} \cdot \int e^{-2\gamma x}\, dx$$

and for large depth x, this reduces to $B/\gamma\lambda^4$.

Using the available values of γ for wavelengths longer than 522 mμ, Prof. Raman estimated that the luminosity of the deep sea may be expressed in terms of the scattering by equivalent thicknesses of air as below :

Luminosity of deep-water

λ in mμ →	658	622	602	590	579	558	522	494	450	410
Equivalent kilometers of dust-free air	0·4	0·5	0·7	1·4	2·5	3·0	50	40	24	15

The scattering by the air column being itself blue, the diminution of intensity in the red, orange and yellow regions of the spectrum, in the case of water, shifts the centre of gravity of the colour of the sea towards the violet. The deeper blue colour of the sea as compared to the blue of the sky is thus readily accounted for. Attention may be drawn to the subsequent paper of Ramanathan, "On the Colour of the Sea" where he deals with the problem in some greater detail and shows how the above results are confirmed and how the presence of increasing amounts of suspended matter as one approaches the sea coast endow the sea with a greenish and later a whitish colour (*Phil. Mag.* : Vol. XLVI, Sept. 1923).

4. HOW THE STUDY OF A NATURAL PHENOMENON, *viz.*, THE BLUE OF THE SEA, LEADS TO A NEW EPOCH OF LABORATORY RESEARCH ON THE CONSTITUTION OF MATTER IN ALL THE THREE STATES ?

Immediately after sending away the paper discussing the above important results, Professor Raman lost no time in writing up his Memoir entitled, "The Molecular Diffraction of Light" in the several chapters of which, besides discussing results already obtained, he planned out the many further experimental and theoretical researches to be undertaken most urgently to investigate the molecular diffraction of light by matter in the gaseous, liquid and solid states, during the transitions from the gaseous to the liquid, and from the liquid to the solid state ; in liquid mixtures in solutions and in relation to the shape and chemical structure of the molecule. In this remarkable and prophetic Memoir, Prof. Raman has discussed even the possible implications of the quantum theory. The Memoir was published by the Calcutta University Press in February 1922, indeed as rapidly as the author wrote it out. This momentous programme of work occupied him and successive bands of his pupils during the ensuing decades and led to no less than the discovery of the "Raman Effect" by 1928. This was immediately followed by Prof. Raman being awarded by 1930 the highest distinction of the Nobel Prize in Physics.

5. CONCLUDING REMARKS

In conclusion what we have to note is the important fact that the curiosity to study and explain observations out at sea brought the problem into the Laboratory and thereafter opened out an entirely new vista of impressive fundamental researches in Modern Physics and the interaction between Matter and Radiation.

DYNAMICS OF CRYSTAL LATTICES

R. S. KRISHNAN

Department of Physics, Indian Institute of Science, Bangalore-12

ONE of Prof. Raman's major contributions to crystal physics was the formulation of the dynamical theory of crystal lattices. Unfortunately, this led to a long-drawn-out controversy between Prof. Raman and Prof. Max Born, which indirectly had its own repercussions on the work of the Bangalore School. It is, therefore, considered desirable to take this opportunity to present a critical review of the theories of lattice dynamics with special reference to experimental facts.

A knowledge of the vibration spectrum of a crystal is an essential prerequisite for the evaluation of many of its physical properties. There are two approaches possible for the determination of the vibration spectrum. The first is a phenomenological one of obtaining the desired information from spectroscopic studies such as Raman Effect, infrared absorption, luminescence, absorption, diffuse X-ray scattering and from studies on the inelastic scattering of neutrons. The other one is the *a priori* method of finding the possible modes of vibration from a knowledge of the crystal structure and the forces binding the atoms together by a dynamical investigation. The theoretical approach to the problem was first initiated by Born and von Karman[88] who gave a most general method of calculating the vibration spectra of solids taking into account their atomic nature. Although the theory was formulated in 1912, it remained dormant for a considerable period because of computational difficulties and for want of progress in experimental physics.

Investigations on the diffuse scattering of X-rays by crystals carried out by Prof. Raman during the period 1939-41 led him to suggest a new approach to the dynamics of crystal lattices.[1,2] This became all the more necessary in order to account for the experimental facts of spectroscopy, namely, the observation of a finite number of sharp Raman lines in the spectra of many simple crystals. In a subsequent publication,[3] the new concept concerning the dynamics of a crystal lattice was expressed by Prof. Raman in a more concrete form. A crystal is a geometrical array with a coherent structure of atoms, molecules or ions similarly situated and capable of influencing each other's movements. It follows that the vibrations of such an array should exhibit a high degree of orderliness, approaching the ideal of a perfectly co-ordinated vibration in which the frequency, amplitude and phase are identically the same throughout the crystal. To picture such a vibration, we may first consider the group of the atoms present in an individual cell of the space lattice. The internal vibrations of such a group would comprise several distinct modes determined by the number of atoms present. Each such vibration may then be pictured as occurring in identically the same way in every cell of the crystal lattice. Geometrically, such an oscillation could be represented as a periodic movement, relative to each other, of the interpenetrating simple lattices of similarly-placed atoms of which any crystal may be regarded as built up. Such a vibration would have a uniquely definable frequency and the vibration spectrum of the crystal would, therefore, consist of a finite number of discrete monochromatic frequencies.

Nearly a year-and-a-half later, Prof. Raman[4] formulated a quantitative treatment of his theory. The basic postulate of Raman's theory is the definition of the normal mode as stated by Lord Rayleigh, *i.e.*, "All particles in a normal vibration have at any instant the same or opposite phase of vibration". In a normal mode of a crystal equivalent atoms in adjacent cells must vibrate with the same amplitude with the same or opposite phases along one, two or all three of the Bravais axes of the crystal. Therefore, if the ratio of the amplitudes of the atoms in adjacent cells along the three principal directions are α, β, γ, then these can take only the values $+1$ or -1. Also the values of α, β and γ must be the same for all the non-equivalent atoms in the unit cell. If the two nearest equivalent atoms have the same phase, the third must also have the same phase and the phases of the motion are pictured as $+++$. If they have opposite phases, the motion must be like $+-+-$. These two possibilities arise for translation along one of the primitive axes. The two other axes have two such cases associated with each and the total number of discrete possibilities is therefore 8. If there are p atoms in the unit cell, there are $3p$ equations for the modes for each case. According to Raman dynamics, the problem actually reduces to the determination of the modes of oscillation of a super cell having twice the unit cell dimensions and eight times the volume of the unit cell, and containing $8p$ atoms. Therefore, excluding the three translations, there are $24p-3$ modes of vibration of the super cell out of which $(3p-3)$ modes are invariant to lattice translations, while the $21p$ modes have opposite phases at least along one of the three axes and are therefore forbidden to appear in the Raman Effect as fundamentals. Quantitative rules governing the intensities of these modes and their activity in infrared and Raman processes for cubic crystals have been given by Raman.[68–81] The $(3p-3)$ modes could give rise to a first order Raman spectrum if allowed by the selection rules. In the second order Raman spectra, overtones and combinations of the $21p$ normal modes are expected in addition to those of the $(3p-3)$ modes.

On the basis of the Raman theory, the modes of oscillation of the 14 Bravais lattices were worked out by Ramachandran.[7] Raman has given a physical picture of the $21p$ modes in any cubic crystal. In the case of the rock salt lattice, for example, the $21p$ modes are the oscillations relative to each other of the alternate planes of equivalent atoms in the crystals, the planes being the octahedral and the cubic. Since there are four sets of octahedral and three sets of cubic planes, these oscillations acquire four-fold and three-fold degeneracies respectively. A further double degeneracy occurs for the transverse modes and the total number of discrete vibrations is reduced further. Excluding the translations, the total number of modes with distinct frequencies is 9 and 11 for NaCl and CsCl lattices respectively. In the case of diamond structure, the total number of modes reduces to 8. A normal co-ordinate analysis of these modes is available from the planar force constant methods of Ramanathan[34–37] for the different cubic lattices.

The only experimental data available in the literature at that time were the results on rock salt observed by Rasetti.[89] The author[9] attempted an interpretation of the spectrum of rock salt with some success. In order to verify the theory further, the author[13] recorded the second order spectrum of diamond using the powerful 2537 Å resonance radiation. The frequency shifts of the prominent lines appearing in the diamond spectrum were also accounted for on the Raman theory. Similar results were reported with other alkali halides besides rock salt from the author's laboratory. It should be emphasized that in all these cases, the Raman spectra exhibited a continuum superposed over the lines, the appearance of which could not be explained on the Raman theory. This is a serious limitation.

The publication of the experimental results on diamond and rock salt by the author stimulated Born and his group to attempt a theoretical explanation of the observed second order spectra on the basis of the Born lattice dynamics. The theory of Born and von Karman regards a crystal as an interacting mechanical system of pN particles where p is the number of particles in the unit cell and N is the number of unit cells in the volume element V which is taken to be sufficiently large. The radiation with which the crystal interacts is regarded as being enclosed in a large box, the dimensions of the crystal being very small compared with the box, yet very large compared with the size of the unit cell. Thus, the crystal is considered as a large molecule and to determine the frequency spectrum, the classical equations of motion for the lattice are set up; the solutions of the independent normal vibrations are plane waves. If the length of the parallelepiped of Np atoms along any one direction is $2na$ where n is the number of cells in that direction, and $2a$ is the lattice constant, then all wavelengths, $2na/r$, where r is any integer, are permissible along that direction. Thus, on the basis of the Born dynamics, the vibration spectrum of any crystal should exhibit a continuous distribution of frequencies. These waves have their phases continuously changing from cell to cell and cannot represent normal modes according to Raman. The frequencies of the different modes of vibration of the lattice are related to their wave-vectors by the dispersion relation: $\omega = \omega_j(\kappa)$ where index j signifies a particular branch of the multi-valued function.

The next step in Born's theory is to identify these waves with the $3Np$ modes of oscillations which the parallelepiped should exhibit. This is achieved by applying the rule that the distribution of frequencies is the same as those of a hypothetical crystal satisfying the 'cyclic boundary conditions'. The total number of the value of the permissible wave vectors (κ), $(\kappa = 1/\lambda)$, then gets limited to N. Since for every value of κ, we have $3p$ frequencies of vibration, the total number of vibrations is 3 pN in agreement with the expected total degrees of freedom. Along any direction of the crystal the dispersion curves have 3 p branches of which (3 p − 3) constitute the optical branches and the remaining 3 acoustic branches. Thus, on the basis of the Born dynamics, the vibration spectrum of any crystal should exhibit a continuous distribution of frequencies starting from 0 to a maximum value, ω_L. Since the frequency values are densely distributed in the reciprocal space, a frequency distribution function $g(\omega)$ can be specified to the number of modes whose frequencies lie in the region ω and $\omega + d\omega$ and this function is such that:

$$\int_0^{\omega_L} g(\omega)\, d\omega = 3pN.$$

Various methods have been suggested for evaluating the frequency distribution function for cubic crystals on the Born theory. Of these, Houston's method is less laborious to apply and hence using his method the distribution functions and dispersion curves have been calculated for a large number of alkali halides and crystals belonging to the diamond structure using different types of force constant models. Placzek and Van Hove[90] showed that the energy distribution of neutrons incoherently scattered by one phonon process is directly connected with the frequency distribution function of the crystal and hence each observed group of scattered neutrons will yield a pair of values of ω and κ belonging to the dispersion relation which can thus be constructed by repeated observation. This was done experimentally for the first time by Brockhouse and Iyengar[91] thereby establishing the validity of the Born-Karman theory of the vibrations of a crystal. Such dispersion curves are not envisaged in the Raman theory. By comparing the experimentally observed dispersion curves in the case of many cubic crystals with those to be expected theoretically on the Born theory using various lattice dynamical models, it has been possible to fix up the particular type of force constant model which gives the best fit for any particular crystal.

According to the selection rules, only the (3 p − 3) frequencies in the limit $k \to 0$ can appear in the first order Raman Effect or infrared absorption, while in the second order Raman spectrum, all combinations of frequencies from the same wave vector including those from the acoustic branches are allowed. The second order Raman spectra of all cubic crystals should be of the nature of a continuum extending from 0 to $2\omega_L$ exhibiting some broad maxima. The inadequacy of the continuous frequency distribution as envisaged in the Born theory to explain the sharp lines observed in the Raman spectra of diamond and alkali halides gave rise to the concept of the critical points[92] and their activity in optical processes. At a critical point there is a discontinuity in the scope of the frequency distribution and the phonon frequencies corresponding to these critical points can appear as octaves and combinations in the second order Raman and infrared absorption processes. Johnson and Loudon[93] applied these critical point phonon frequencies and the selection rules for their activity as given by Briman[94] for the interpretation of the frequency shifts of the prominent peaks or lines in the second order Raman spectra and infrared absorption spectra of diamond and alkali halides.

From a critical examination of the Raman dynamics in terms of the Born dynamics, it was pointed out by the author[84] that the modes of vibration corresponding to the prominent critical points Γ, L, X, M and R are identical with the super cell modes envisaged in the Raman theory. These critical points except Γ are situated at the extremities of the dispersion curves along symmetry directions of the crystal lattice and, therefore, involve a phase difference of π at least along one of three axes. In the case of NaCl type of structures, there are 1 Γ, 4 L and 4 X critical points making a total of 9 modes with distinct frequencies which correspond to the nine Raman modes for this type of structure.[6] In the case of the CsCl structure, there are 1 Γ, 2 R, 4 M and 4 X critical points making a total of 11 modes corresponding to the 11 Raman modes.[6] The frequencies of the Raman modes have been identified and estimated from the dispersion curves obtained from experiments on the inelastic scattering of neutrons in the case of alkali halides[82–87] and have been used to account for the frequency shifts of the prominent lines in their second order Raman spectra. In conclusion, it is of interest to note that Raman dynamics formulated in 1943 contains the essential part of the most general theory and is an extremely practicable and simple approach for getting a physical and quantitative account of the super cell modes. The octaves and combination of the super cell modes which are allowed in the two phonon scattering processes account for the prominent features of the observed second order spectra of cubic crystals. In order to account for the minor details, it is necessary to take into consideration the higher order super cell modes in the Raman theory corresponding to critical points ω, Σ, Δ, Ω, etc.

Expressions for the frequencies of the Raman modes are available[68-73] and the analysis is very simple even though the inclusion of polarisability and ionic character can improve the agreement between the observed and calculated frequencies. The expressions for the elastic constants, and for the limiting frequencies along symmetry directions calculated on this model agree well with those calculated on the conventional lattice dynamics of Born using suitable force constant models. It is to be pointed out that neither Raman dynamics nor the most general Born dynamics as worked out at present can offer any satisfactory explanation for the intensity distribution and the polarisation characteristics of the second order Raman spectra.

The complete bibliography on Raman lattice dynamics and its applications is appended below.

---

1. Raman, C. V., "Crystals and photons," *Proc. Ind. Acad. Sci.*, 1941, 13, 1.
2. —, "The thermal energy of crystalline solids : Basic theory," *Ibid.*, 1941, **14**, 459.
3. —, "New concepts of the solid state," *Ibid.*, 1942, 15, 65.
4. —, "Vibration spectrum of a crystal lattice," *Ibid.*, 1943, 18, 237.
5. Bhagavantam, S., "Normal oscillations of the diamond structure," *Ibid.*, 1943, **18**, 251.
6. Chalam, E. V., "The normal vibrations in some typical cubic crystals," *Ibid.*, 1943, 18, 257.
7. Ramachandran, G. N., "Modes of atomic vibrations in the fourteen Bravais lattices," *Ibid.*, 1943, 18, 266.
8. Chalam, E. V., "Normal vibrations of crystal lattices : Application of group theory," *Ibid.*, 1943, 18, 283.
9. Krishnan, R. S., "Raman spectra of crystals and their interpretation," *Ibid.*, 1943, 18, 298.
10. Chalam, E. V., "Character tables of atomic vibrations in some cubic crystals," *Ibid.*, 1943, 18, 327.
11. Ramachandran, G. N., "Modes of virbration of the hexagonal close packed lattice," *Ibid.*, 1943, 18, 341.
12. Chalam, E. V., "The frequency spectrum of the diamond lattice," *Ibid.*, 1943, **18**, 334.
13. Krishnan, R. S., "The Raman spectrum of diamond," *Ibid.*, 1944, **19**, 216.
14. Dayal, B., "The evaluation of the specific heat of the rock salt by the new crystal dynamics," *Ibid.*, 1944, 19, 182.
15. Dayal, B., "The lattice spectrum and specific heat of diamond," *Ibid.*, 1944, **19**, 224.
16. —, "The specific heat of metals crystallising in the cubic system," *Proc. Ind. Acad. Sci.*, 1944, **20**, 24.
17. —, "The specific heats of the alkali halides," *Ibid.*, 1944, **20**, 77.
18. —, "The specific heat of metallic silicon," *Ibid.*, 1944, 20, 87.
19. —, "Lattice spectrum, specific heat and thermal expansion of lithium and sodium fluoride," *Ibid.*, 1944, **20**, 138.
20. —, "Theory of the thermal expansion of the alkali halides," *Ibid.*, 1944, **20**, 145.
21. —, "The theory of the thermal expansion of diamond," *Ibid.*, 1944, **20**, 87.
22. Dayal, B., "The thermal expansion of metals at low temperatures," *Ibid.*, 1944, **20**, 187.
23. Bhagavantam, S., "Normal oscillations of the T class diamond structure," *Ibid.*, 1944, 20, 122.
24. Krishnan, R. S., "The second order Raman spectrum of diamond," *Ibid.*, 1946, **24**, 25.
25. Raman, C. V., "The vibration spectra of crystals, Part I : Basic theory," *Ibid.*, 1947, **26**, 339.
26. —, "The vibration spectra of crystals, Part II : The case of diamond," *Ibid.*, 1947, 26, 356.
27. —, "The vibration spectra of crystals, Part III : Rock salt," *Ibid.*, 1947, **26**, 370.
28. —, "The vibration spectra of crystals, Part IV : Magnesium oxide," *Ibid.*, 1947, **26**, 383.
29. —, "The vibration spectra of crystals, Part V : Lithium and sodium fluorides," *Ibid.*, 1947, 26, 391.
30. —, "The vibration spectra of crystals, Part VI ; Sylvine," *Ibid.*, 1947, **26**, 396.
31. Krishnan, R. S., "The scattering of light in diamond and its Raman spectrum," *Ibid.*, 1947, 26, 399.
32. —, "The Raman spectrum of rock salt and its interpretation," *Ibid.*, 1947, **26**, 419.
33. —, "Raman spectrum of ammonium chloride and its variation with temperature," *Ibid.*, 1947, 26, 432.
34. Ramanathan, K. G., Dynamical theory of the vibration spectra of crystals, Part I : Diamond," *Ibid.*, 1947, 26, 481.
35. —, "Dynamical theory of the vibration spectra of crystals, Part II : The rock salt structure," *Ibid.*, 1947, 26, 493.
36. —, "Dynamical theory of the vibration spectra of crystals, Part III : The caesium chloride structure," *Ibid.*, 1947, 26, 500.
37. —, "Dynamical theory of the vibration spectra of crystals, Part IV : The metallic crystals," *Ibid.*, 1947, 26, 507.
38. Krishnan, R. S., "Raman spectrum of ammonium bromide and its variation with temperature," *Ibid.*, 1948, 27, 321.
39. — and Narayanan, P. S., "The vibration spectra of the alkali halides," *Ibid.*, 1948, **28**, 296.
40. Ramanathan, K. G., "Theoretical evaluation of the acoustic wave velocities in diamond," *Ibid.*, 1948, 28, 370.
41. —, "The dynamical theory of the vibration spectra of crystals, Part V : Fluorspar structure," *Ibid.*, 1948, 28, 454.
42. —, "The dynamical theory of the vibration spectra of crystals, Part VI : The zinc sulphide structure," *Ibid.*, 1948, 28, 459.

43. Krishnamurthy, D., "Evaluation of the elastic constants of diamond from its Raman frequencies," *Proc. Ind. Acad. Sci.*, 1951, 33, 325.

44. Narayanan, P. S., "The distribution of intensity in the Raman spectrum of diamond," ***Ibid.***, 1951, 34, 1.

45. Raman, C. V., "The scattering of light in crystals and the nature of their vibration spectra," *Ibid.*, 1951, 34, 61.

46. Krishnamurthy, D., "Evaluation of the specific heat of diamond from its Raman frequencies," *Ibid.*, 1951, **34**, 121.

47. Raman, C. V., "The vibration spectra of crystals and the theory of their specific heats," ***Ibid.***, 1951, 34, 141.

48. Viswanathan, K. S., "The characteristic vibrations of crystal lattices, Part I," ***Ibid.***, 1953, 37, 424.

49. —, "The characteristic vibrations of crystal lattices, Part II," ***Ibid.***, 1953, 37, 435.

50. Raman, C. V., "The nature of the thermal agitation in crystals," ***Ibid.***, 1955, 42, 163.

51. —, "The thermal energy of crystals," *Curr. Sci.*, 1955, 24, 357.

52. Narayanan, P. S., "Raman spectrum of caesium bromide," *Proc. Ind. Acad. Sci.*, 1955, 42, 303.

53. Raman, C. V., "The physics of crystals," ***Ibid.***, 1956, 43, 327.

54. —, "The diamond," ***Ibid.***, 1956, 44, 99.

55. —, "The specific heats of crystals, Part I : General theory," ***Ibid.***, 1956, 44, 153.

56. —, "The specific heats of crystals, Part II : The case of diamond," ***Ibid.***, 1956, 44, 160.

57. —, "Quantum theory and crystal physics," ***Ibid.***, 1956, 44, 361.

58. —, "The specific heats of crystals, Part III : Analysis of experimental data," ***Ibid.***, 1956, 44, 367.

59. —, "The specific heats of some metallic elements, Part I," ***Ibid.***, 1957, 45, 1.

60. —, "The specific heats of some metallic elements, Part II : Approximate theoretical evaluation," *Ibid.*, 1957, 45, 7.

61. —, "The specific heats of some metallic elements, Part III : The characteristic frequencies," ***Ibid.***, 1957, 45, 59.

62. —, "The specific heats of some metallic elements, Part IV : The residual spectrum," ***Ibid.***, 1957, 45, 139.

63. —, "The specific heats of crystals and the fallacy of the theories of Debye and Born," ***Ibid.***, 1957, 45, 273.

64. —, "The specific heats of crystalline solids, Part I," *Curr. Sci.*, 1957.

65. —, "The specific heats of crystalline solids : Part II," *Ibid.*, 1957.

66. —, "The heat capacity of diamond between 0 and 1000° K.," *Proc. Ind. Acad. Sci.*, 1957, 46, 323.

67. Krishnan, R. S. and Narayanan, P. S., "Raman spectra of alkali halides," *J. Ind. Inst. Sci.*, 1957, 39, 85.

68. Raman, C. V., "The vibrations of the MgO crystal structure and its infrared absorption spectrum, Part I : Results of experimental study," ***Ibid.***, 1961, **54**, 205.

69. Raman, C. V., "The vibrations of the MgO crystal structure and its infrared absorption spectrum, Part II : Dynamical theory," *J. Ind. Inst. Sic.*, 1961, 54, 223.

70. —, "The vibrations of the MgO crystal structure and its infrared absorption spectrum, Part III : Comparison of theory and experiment," ***Ibid.***, 1961, 54, 233.

71. —, "The vibrations of the MgO crystal structure and its infrared absorption spectrum, Part IV : Evaluation of its specific heat," ***Ibid.***, 1961, 54, 244.

72. —, "The spectroscopic behaviour of rock salt and the evaluation of its specific heat, Part I : The structure and its free vibrations," ***Ibid.***, 1961, 54, 253.

73. —, "The spectroscopic hehaviour of rock salt and the evaluation of its specific heat, Part II : Its infrared activity," ***Ibid.***, 1961, 54, 266.

74. —, "The spectroscopic behaviour of rock salt and the evaluation of its specific heat, Part III : The spectrum of light scattering," ***Ibid.***, 1961, 54, 281.

75. —, The spectroscopic behaviour of rock salt and the evaluation of its specific heat, Part IV : Specific heat and spectral frequencies," ***Ibid.***, 1961, 54, 294.

76. —, "The infrared absorption of diamond and its significance, Part VI : The free vibrations of its structure," *Ibid.*, 1962, 55, 24.

77. —, "The infrared absorption of diamond and its significance, Part VII : "The characteristic frequencies," ***Ibid.***, 1962, 55, 30.

78. —, "The infrared absorption of diamond and its significance, Part VIII : Dynamical theory," *Ibid.*, 1962, 55, 36.

79. —, "The infrared absorption of diamond and its significance, Part IX : The activity of the normal modes," ***Ibid.***, 1962, 55, 42.

80. —, "The infrared absorption of diamond and its significance, Part X : Evaluation of the specific heat," *Ibid.*, 1962, 55, 49.

81. —, "The vibration spectrum of lithium fluoride and the evaluation of its specific heat," *Ibid.*, 1962, 55, 131.

82. Krishnamurthy, N. and Krishnan, R. S., "Raman spectrum of caesium iodide," *Ind. Jour. Pure Appl. Phys.*, 1963, 1, 239.

83. Krishnan, R. S., "Dynamics of liquids and solids by optical spectroscopy," *Inelastic Scattering of Neutrons*, International Atomic Energy Agency, 1965, 2, 537.

84. —, "Raman spectra of cubic crystals," *Ind. Jour. Pure and Appl. Phys.*, 1965, 3, 424.

85. Krishnamurthy, N. and Krishnan, R. S., "Raman spectra of alkali halides," *Z. Physik*, 1965, 183, 130.

86. Krishnan, R. S. and Krishnamurthy, N., "The Raman spectra of gallium phosphide," *La Jour. de Phys.*, 1965, 56, 630.

87. — and —, "The second order Raman spectrum of calcium fluoride," ***Ibid.***, 1965, 26, 633.

OTHER REFERENCES

88. Born, M. and Von Karman, *Phys. Zeits.*, 1912, 13, 297.

Fermi, E. and Rasetti, F., *Z. Physik*, 1931, 171, 689.

89. Rasetti, F., *Nature*, 1931, **127**, 626. Born, M., *Dynamik der Kristallgiller Tenbuer*, 1915.

90. Placzek, G and Van Hove, L., *Phys. Rev.*, 1954, **93**, 1207.

91. Brockhouse, B. N. and Iyengar, P. K., *Phys. Rev.* 1957, **108**, 894.

92. Van Hove, L., *Ibid.*, 1953, **89**, 1189.

93. Johnson, F. A. and Loudon, R., *Proc. Roy. Soc.* 1964, **281**, 274.

94. Birman, J. L., *Phys. Rev.*, 1963, **131**, 1489.

SIR C. V. RAMAN'S WORK ON THE DYNAMICS OF VIBRATIONS

B. S. MADHAVARAO

Indian Institute of Science, Bangalore

I WISH to refer here briefly to some mathematical aspects of the earlier work of Raman related to the theory of vibrations of several types. This work was done during the years 1914 onwards at Calcutta when he was greatly interested in acoustics, specially in the subject of Indian musical instruments. It is interesting to recall in this connection a few remarks made by Dr. Ganesh Prasad, a pure mathematician of high calibre, in his Presidential Address to the Physico-Mathematics Section of the Indian Association for the Cultivation of Science (Report for 1914, p. 39), *viz.*, "Prof. Raman is well known to you all as an experimentalist of worldwide reputation. But some of you will feel surprised to learn that by his recent mathematical researches, he has firmly established his claim to be considered a sound mathematician. The two papers which he read before the Calcutta Mathematical Society during the current year are very valuable, and I trust he will continue his mathematical researches." It is indeed fortunate for science that Raman did not take Ganesh Prasad's advice to continue research in mathematics for its own sake, but, like a sound mathematician, decided to use mathematics to help him expound new physical phenomena of his own creation!

His contributions to the theory of vibrations have been numerous, but I shall just choose a few which appear to be of mathematical interest. The first one relates to the general investigations on the maintenance of vibrations in strings (*Bull. No.* 6, 1912, *Ind. Assoc. Cult. Science*), and deals with several topics, specially the difficult case of the inhomogeneous string. The nature of the mathematics employed is the one based on Rayleigh's classical book on the "Theory of Sound", which Raman had thoroughly mastered. Plenty of mathematics has been used, but is always accompanied by experimental details illustrating the mathematical results, and also the different types of maintenance are explained by beautiful figures. It is well known that the topic of vibrations of an inhomogeneous string is really the Sturm-Liouville eigenvalue problem (Hilbert-Courant, *Methoden der Math. Phys.*, 1924, p. 237), and it is interesting to note that Raman has beautifully succeeded in transferring this eigenvalue problem for the case of maintenance of vibrations also, by simple physical explanations rather than by the use of the difficult mathematical techniques involved. Such an approach is also evident in his investigations (*Bull. No.* 11, 1914) on the maintenance of combinational vibrations by two simple harmonic forces, and by other types of periodic fields.

The most interesting of his researches on the vibration of strings is contained in the comprehensive memoir (*Bull. No.* 15, 1918, pp. 1-157) on the mathematical theory of the vibration of bowed strings, and of musical instruments of the violin family with experimental verifications of the results. The necessary dynamical theory is developed using Langrange's equations of motion for simple and forced vibrations, and the notion of normal co-ordinates. A Fourier analysis is made of the types of possible motions, and the difficult question of convergence of the Fourier series is dealt with in a physically intuitive manner, using just the essential mathematical steps. In view of the complexity of the problem, emphasis is laid upon the cases which are of practical interest, and the choice of these cases exhibits clearly his ability to overcome difficult mathematical hurdles. This certainly goes to his credit if only we realise that, even with the present-day techniques of mathematical physics relating to vibration and eigenvalue problems, the complex case dealt with in this *Memoir* cannot be solved in full. One of the important results in this paper is the quantitative explanation of the effect of a mute on the quality of the violin tune. Another remarkable result of mathematical interest is his analysis of the nature of motion when n, the number of discontinuities, is a prime > 1, or is composite. A careful examination of the manner in which this analysis is accomplished shows that he has not used any sophisticated results of prime number theory, but just the definition of a prime number!

Another investigation relating to the vibrations of circular membranes is also of great interest. It is well known that percussion instruments, generally speaking, give rise to inharmonic overtones, and are thus musically imperfect. The Indian Mridanga forms a remarkable exception to this rule as found by Raman experimentally. The character of vibrations of the associated heterogeneous membrane which gives rise to these significant properties was investigated by sand figures, and definite quantitative results obtained. The problem of oscillations of heterogeneous membranes is a complicated one, and it is difficult to solve it completely with all the resources of advanced mathematical physics. It is again a general Sturm-Liouville eigenvalue problem, whose solution demands an extensive knowledge of integral equations theory (Hilbert, *Ibid.*, pp. 255, and 10, p. 273). It is very interesting to note that the result of physical interest mentioned at the end of paragraph 2, p. 279 of the above reference is inherent in Raman's experimental results.

Lastly, a result of rather academic interest is Raman's attempt at a classical derivation of the Compton effect (of which the Raman Effect is the optical analogue) by using the theory of vibrations (*Ind. J. Phys.*, 3, p. 357) based on the result that even the most arbitrary type of wave disturbance can be represented as the superposition of plane trains of waves travelling in all directions in space.

In conclusion, I might mention that Raman always evinced a keen interest in topics of mathematics, even of the purest type. I remember, when I was a student of the M.Sc. Pure Mathematics course of the Calcutta University during 1919-21, and he was the Palit Professor of Physics, his finding time to question me (a young student of about 20 years then) as to what I was learning, and listen to my talking about topics like Algebra of Quantics, Projective and Differential Geometry. He retained this interest in Pure Mathematics, which he often likened to an art like painting or music, throughout his life. Such great men of wide interests, and broad vision are rare indeed.

ELASTIC CONSTANTS AND SUB-HARMONICITY

B. R. SETH
Dibrugarh University, Dibrugarh, Assam

1. Introduction

ONE of the subjects which interested C. V. Raman was that of internal couple-stresses produced in crystals subjected to severe deformation. This required the introduction of additional elastic constants. He applied it to the determination of the elastic constants of cubic crystals at the macro-level.

Internal moments are essentially a micro-phenomenon and cannot be of much use in macro-measurements of elastic constants. Recently, unsuccessful attempts have been made to use this concept to explain fatigue. It is also being used in turbulence where it may bear some fruit, as any further work in this subject must now be at the macro-level.

As regards rotation effects, these can be produced by the second order terms in the strain tensor itself, which are neglected in the classical treatment. Actually, the elastic fields are sub- or super-harmonic in character, and, contain rotation or spin effects as particular cases. The classical bi-harmonic or harmonic fields are only degenerate forms, and hence do not exhibit these effects. If this is taken into consideration, the assumption of additional elastic constants for crystals, isotropic at the macro-level, need not be made. We shall now prove the sub- or super-harmonicity of the elastic fields.

2. Equations of Equilibrium

Let the undeformed and the deformed coordinates of the position of a particle be X^r and x^r, $(r = 1, 2, 3)$ respectively, so that the deformation is given by

$$u^r = x^r - X^r, \quad x^r = f^r(X^1, X^2, X^3)$$
$$(x^1, x^2, x^3) = (x, y, z). \tag{2.1}$$

Assuming for simplicity that both systems are rectangular cartesian the Almansi strain tensor is:

$$2e_{ij} = \delta_{ij} - X^{\alpha}{}_{,i} X_{\alpha,j} = u_{i,j} + u_{j,i} - u^{\alpha}{}_{,i} u_{\alpha,j}. \qquad (2.2)$$

A linear stress-strain tensor law is quite adequate for our purpose, so that

$$\begin{aligned} T_{ij} &= \lambda\delta_{ij}e_{aa} + 2\mu e_{ij} \\ &= \lambda\delta_{ij}e_{aa} + \mu\,(\delta_{ij} - X^{\alpha}{}_{,i,} X_{\alpha,j}), \end{aligned} \qquad (2.3)$$

where

$$2e_{ca} = 3 - X^{\alpha}{}_{,i} X_{\alpha,i} \qquad (2.4)$$

and the comma denotes differentiation with respect to i or j. It should be noted that $e_{\sigma\alpha}$ is the first strain invariant of the Almansi tensor.

Substituting the value of T_{ij} from (2.3) in $J_{ij,j} = 0$ and simplifying, we get

$$e_{aa,i} = \tfrac{1}{2} c J_{ij} (X^r, X^r{}_{,j}). \qquad (2.5)$$

In (2.5) J_{ij} is the Jacobian of X^r and X^r, j. with respect to x^i and x^j and

$$c = \frac{2\mu}{\lambda + 2\mu} = \frac{1 - 2\sigma}{1 - \sigma}. \qquad (2.6)$$

A typical form of (2.5) is

$$\begin{aligned} \frac{\partial e_{aa}}{\partial x} = \frac{1}{2} c\,[&J_{xy} (X^1, X^1, y) + J_{xz} (X^1, X^1, z) \\ &+ J_{xy} (X^2, X^2, y) + J_{xz} (X^2, X^2, z) \\ &+ J_{xy} (X^3, X^3, y) + J_{xz} (X^3, X^3, z)]. \end{aligned} \qquad (2.7)$$

Eliminating e_{aa} between the three equations taken in pairs, we get

$$J_{ij} (X^r, \nabla^2 X^r) = 0. \qquad (2.8)$$

It should be noted that

$$\nabla^2 \equiv \frac{\partial}{\partial x^i} \frac{\partial}{\partial x^i}, \quad \nabla_0{}^2 \equiv \frac{\partial}{\partial X^i} \frac{\partial}{\partial X^i}.$$

A typical form of (2.8) is

$$J_{xy} (X^1, \nabla^2 X^1) + J_{xy} (X^2, \nabla^2 X^2) + J_{xy} (X^3, \nabla^2 X^3) = 0. \qquad (2.9)$$

The complete solution of the equation (2.8) is

$$\nabla^2 X^r = \nabla_0 T (X^1, X^2, X^3), \qquad (2.10)$$

where

$$\nabla_0 = i \frac{\partial}{\partial X^1} + j \frac{\partial}{\partial X^2} + k \frac{\partial}{\partial X^2},$$

$$J_{ij} (X^i, X^j) \neq 0, \quad i, j = 1, 2, 3$$

and T is an arbitrary function of $X^r{}_r$

From (2.10) we see that X^r are sub- or superharmonic functions.

MY PROFESSOR

N. S. NAGENDRA NATH

University Professor of Mathematics, Patna University, Patna-5

IT was just a happy and unforgettable event in my life that I met my Professor by sheer accident who had just joined the Indian Institute of Science as its Director and Professor of Physics, and I had gone to the Institute to secure admission in the Electrical Technology Department. When I was leaving the Department after securing admission, I said to myself, why not meet the Nobel Laureate on the plea of becoming his research scholar! I had no hope that I would get admission in the Physics Department as a research scholar as I had graduated in mathematics. After a thorough interview lasting till the evening, he stood up and patted me and said that I could join the Department as his research scholar. I then told him my plight that I had already secured admission in the E.T. Department. He appeared to feel annoyed but then he said that I had to give up the admission in the E.T. Department. I said that I would very gladly do so and join his Department. I was overwhelmed by his kindness and generosity, and academic outlook which appeared to me like a mountain peak and I had chosen my *guru* from that moment.

The new Department of Physics had to be organised. The work that was entrusted to me was to prepare a list of books in Physics and Mathematics for the library. I prepared a long list which contained quite a number of books in the purest of Pure Mathematics which could only be procured from Köhlers Antiquarium in Germany. I had thought that the Professor would make his own selection from my list, but he simply dittoed the list and said that I had to prepare additional lists from time to time.

One day I picked up enough courage to tell him that a teacher of mine who was exceptionally brilliant in Pure Mathematics was at that moment without a job. He said: "Do you really think so?" "Yes," I replied. "All right, ask him to meet me," he said. The teacher met him and he was taken as a research scholar. Professor observed no water-tight compartments between one subject and another and this was to be seen in his lectures drawing analogies from one discipline to another.

I do not remember a single occasion when Professor talked with me anything other than academic problems. When we were discussing some problem, he received the day's dak which contained a letter from Professor V. M. Goldtschmidt that he would accept an assignment in the Institute. A letter from a top scientist in the Siemens had also been received indicating that he too would accept an assignment in the Institute. Professor was perhaps in contact with a number of others also.

His encouragement to beginners was unsurpassed. One day when I told him that I had found the explanation of the Raman line in diamond which had been mentioned by him as an outstanding problem in his Nobel address, he asked me what it was. I said that the Raman line was to be attributed to the mutual vibration of the two face-centred lattices composing the diamond lattice ; he simply yelled out, "You are right, you are right," and insisted that the research paper should be immediately written up. He was in ecstasy over this work. I found myself elected to the Fellowship of the Indian Academy of Sciences at the age of 23 years of which Professor had given no inkling to me.

One day, Parthasarathy was to give an account of the determination of the velocity of sound in organic liquids by the method of diffraction of light by ultrasonic waves. Hardly had he finished the description of the experimental set-up, than Professor raised the query —What is the number of diffraction orders expected on the basis of Brillouin's theory ?—The reply was two first orders of weak intensity. What was the fact, was the next query. A number of diffraction orders not in agreement with the theory. Professor went to the board and said that the theory should be developed in a different way. A sound wave creates compressions and rarefactions. A light beam would be slowed in the region of compressions and it would move faster in the region of rarefactions, and so a plane wavefront would become a corrugated wavefront like a zinc sheet used for building purposes. Professor said that an analysis of this corrugated wavefront would explain the unexplained results. When I went to him next day giving an explanation of the results on the basis of his ideas, he said it was all correct and that started a series of papers by him and myself which has come to be known in literature as Raman-Nath Theory. Though his outlook was essentially that of an experimental physicist, he would insist on the physical significance of every theoretical result. He had a stock in trade of certain physical results and he would liberally draw on them to explain results in a different subject altogether. Once Professor Max Born exclaimed, "He leaps over Mathematics.'

In November 1969, he and Lady Lokasundari Raman were graciously pleased to attend the marriage reception of my daughter. Professor drew me aside outside the reception hall and told me for nearly half-an-hour that his latest problem was to give a proper theory of earthquakes. The present theories were based on models which were highly deficient as they did not properly take into account the shape of the earth and the wave nature of the disturbance.

The blue of the sky, the blue of the sea, the colours of shells, the colours of flowers, the music of pianoforte string, the music of the Indian musical drum, molecular vibrations, diamond and its properties, crystals, nature of vision, make a gamut of beautiful things which he pursued, and so long as these beautiful things are there, Professor's name will always be there to guide further work. Truly it can be said of his motto in life—

> 'Beauty is truth, truth beauty'—that is all
> Ye know on earth and all ye need to know.
> (KEATS).

THE RAMAN-NATH THEORY

S. CHANDRASEKHAR
Department of Physics, University of Mysore, Mysore-6

IT is scarcely possible in an article of this type to do full justice to Professor Raman's monumental contributions to Optics and Diffraction which extended over a period of six-and-a-half decades. We shall, therefore, confine our attention to an aspect of his work carried out in Bangalore between the years 1935-1937, In 1932, Debye and Sears[1] in the United States and Lucas and Biquard[2] in France described some beautiful experiments on the diffraction of light by ultrasonic waves in a liquid. A parallel beam of monochromatic light is incident normally on a rectangular cell containing a liquid. If the liquid is traversed by ultrasonic waves generated by a quartz oscillator placed at the top of the cell, diffraction spectra are seen in the transmitted beam, similar to those produced by an ordinary ruled grating, the diffraction maxima satisfying the condition $\sin \theta = \pm n\lambda/\lambda^*$, where λ and λ^* are respectively the wavelengths of the incident light and the sound waves in the medium.

These experiments were suggested by a theory given earlier by Brillouin of the scattering of light by thermal waves in a homogeneous medium. The thermal waves give rise to periodic stratifications in the refractive index, so that the light scattering may be looked upon as a Bragg reflexion. The velocity of the waves produces a small Doppler shift in the frequency of the scattered light. In fact, Raman and his co-workers applied this technique to investigate the dispersion of hypersonic velocities in liquids at very high frequencies. Their measurements provided the first conclusive evidence of the existence of a rigidity modulus in *ordinary* liquids at these frequencies, a result which had an important bearing on molecular theories of the liquid state.[3]

The diffraction by artificially generated elastic waves, however, turned out to be a much more complex phenomenon, and it was clear that the elementary theory of the optical grating did not suffice to explain the observations. The intensities of the higher order spectra were considerably greater than expected from the simple theory. Furthermore, the intensity distribution in the different spectra varied in an irregular manner with the change of wavelength and direction of the incident light, as also with the change of amplitude of the sound wave. Debye and Sears[1] at first attempted to explain the higher orders as due to overtones in the quartz crystal. Theories were proposed by Debye,[4] Lucas and Biquard[2] and Brillouin,[5] but none of them accounted for the intensities of the higher orders and their variations under different experimental conditions.

In 1935, Raman and Nagendra Nath[6] put forward an elegant explanation of the phenomenon which at once proved to be a spectacular success. In his treatise on *Ultrasonics*,[7] Bergmann wrote of this theory: "It was a great achievement on the part of Raman and Nagendra Nath when they succeeded in clearing up the greater part of these phenomena, some of which are very complex, in several of their publications...." The basic idea underlying the Raman-Nath theory is that the sound wave acts as a pure *phase* grating so that the emergent optical wavefront is corrugated. This idea at once led to quantitatively satisfactory values of the intensity distribution of the spectra and of the Doppler shifts in the frequency of the diffracted light.

There has been continued interest in the theory because of the large number of applications of the effect in technology and industry. (A full list of references to such applications can be found in Section 10.2 of the annual indexes to the *Journal of the Acoustical Society of America*.) Various refinements of the theory have been developed in subsequent years. A notable contribution was that of Bhatia and Noble,[8] who derived a general and rigorous electromagnetic treatment of the phenomenon. Despite the formal rigour of these later treatments, it is clear from recent publications[9,10] that, in practice, the Raman-Nath equation still offers the best method of computing the intensities of the spectra.

The idea of the phase grating has been used in the theory of scattering of high energy particles by a central force (*see, e.g.*, ref. 11) and also in the interpretation of polarized diffraction patterns from cholesteric liquid crystals.[12]

---

1. Debye, P. and Sears, F. W., *Proc. Nat. Acad. Sci.* (Washington), 1932, **18**, 409.
2. Lucas, R. and Biquard, P., *J. de Phys. et Rad.*, 1932, **3**, 464.
3. Frenkel, J., *Kinetic Theory of Liquids*, Dover, New York, 1955.
4. Debye, P., *Phys. Z.*, 1932, **33**, 849.
5. Brillouin, L., "La Diffraction de la Lumiere par des Ultrasons," *Act. Sci. et Ind.*, 1933.
6. Raman, C. V. and Nagendra Nath, N. S., *Proc. Ind. Acad. Sci.*, 1935, **2 A**, 406, 413; 1936, **3 A**, 75, 119, 495.
7. Bergmann, *Ultrasonics*, Bell (London), 1938.
8. Bhatia, A. and Noble, W. J., *Proc. Roy. Soc.*, 1953, **220 A**, 356.
9. Berry, M. V., *The Diffraction of Light by Ultrasound*, Academic Press, London and New York, 1966.
10. Leroy, O., *Proc. Ind. Acad. Sci.*, 1971, **73 A**, 109.
11. Moliere, G., *Z. Naturf.*, 1947, **29**, 133.
12. Chandrasekhar, S. and Shashidhara Prasad, J., In *Physics of the Solid State*, Academic Press, London and New York, 1969, p. 77.

PROFESSOR RAMAN'S CONTRIBUTIONS TO SPECTROSCOPY

A. K. RAMDAS

Department of Physics, Purdue University, Lafayette, Indiana, USA

In his long and extraordinarily creative scientific career, Professor C. V. Raman made a large number of pioneering contributions to many branches of classical and modern physics. Of these, the Raman Effect, discovered by him in 1928, is rightly regarded as his greatest contribution to contemporary physics. Besides being a very significant discovery in the context of the quantum theory of matter and radiation, it created an entirely new branch of spectroscopy and he can thus be regarded as one of the great spectroscopists of this century. In this article, I wish to recall some of the significant contributions which he and his students made to the study of matter by spectroscopic techniques.

Deeply impressed by the "wonderful blue opalescence of the Mediterranean Sea" during a sea voyage in 1921, Raman embarked[1] on a comprehensive study of scattering of light by matter in all states of aggregation. At this time he had already earned international reputation for his work on physical optics and acoustics ; the study of scattering of light perhaps marks his first serious program in molecular and atomic physics. In the essay entitled, "Molecular Diffraction of Light"[2] he gave a masterly review of the status of the subject in 1922 and identified the significant problems in the field. Chapter VIII, "The Doppler Effect in Molecular Scattering", and Chapter IX, "Molecular Diffraction and the Quantum Theory of Light" are particularly prophetic in the light of subsequent developments. The essay already contained a large number of original observations. The next six years witnessed a steady stream of contributions on light scattering from his laboratory. During the course of these studies "evidence was encountered of the presence of a disturbing effect" ; even in very pure liquids, Rayleigh scattering was accompanied by feeble radiation with altered wavelength.[3] Attempts to spectroscopically analyze this "special type of feeble fluorescence" in 1924 and 1925 were not met with success.[3] The article of 1928, "A New Radiation",[4] gives a beautiful and inspiring account of how Raman took the series of steps in the study of this "feeble fluorescence", ending in the use of monochromatic exciting light provided by a powerful mercury arc and, initially a pocket spectroscope, then a spectrograph, to analyze the scattered radiation. The results were truly dramatic. Each incident exciting line of frequency ω_0 was accompanied by weaker lines of frequency $\omega_0 \pm \omega_i$, $i = 1, 2, 3 \ldots\ldots$ Raman attributed the additional lines to an energy exchange between the incident photon and the quantized energy levels, $\hbar\omega_i$, of the scattering medium, *i.e.*, the new lines $\omega_0 - \omega_i$ and $\omega_0 + \omega_i$ correspond to a partial exchange of energy in which the medium is excited to or de-excited from an energy level $\hbar\omega_i$ above the ground state. The additional lines occur in pairs displaced equally in frequency to the high and the low frequency side of the exciting line. In the very first publication, it was shown that the effect is exhibited by gases, liquids, crystals and amorphous solids and that it is a "phenomenon whose universal nature has to be recognized".[4,5] The new lines observed are characteristic of the scattering medium and the energy shifts of the "Raman lines" are independent of the frequency of the incident radiation. Until very recently, Raman spectroscopy was limited to vibrational and rotational spectra of gases, liquids and crystals which occur in the near and far infrared when studied as absorption spectra. Indeed, the selection rules for Raman and infrared spectra being different, the two techniques are complementary. Moreover, the ease of spectroscopy in the visible region is an attractive feature of Raman spectroscopy.

In the years following the discovery of the Raman Effect, Professor Raman and his students exploited it with great energy and ingenuity. His leadership undoubtedly contributed to a thorough understanding of the various aspects of the subject. A study of the Raman spectra of crystals figured prominently[3] in his program of research from the very first observation of the Raman Effect. Raman spectrum of diamond, Raman spectra of crystalline powders, and a complete study of the effect of crystal orientation on the Raman spectra of single crystals are some of the many investigations which could be cited. In a paper on the α-β transformation of quartz published in 1940, Raman and Nedungadi[6] proposed the very important concept connecting a specific vibrational mode and the phase transition.

Similar ideas were developed independently many years later by Cochran[7] in connection with ferroelectric transitions in crystals. The subject of specific normal modes in relation to phase transition is of great current interest.[8] Raman had an abiding interest in lattice dynamics and stimulated a large number of excellent studies of the second order Raman Effect of crystals using the Rasetti technique.[9]

Another closely related area in light scattering to which Raman and his students made many significant contributions is the spectroscopic analysis of Brillouin scattering in liquids and solids.[10] High resolution interferometry and suitable sources were effectively used to study this phenomenon and a large number of important results were obtained. The work of Raman and Venkateswaran[11] on viscous liquids like glycerine brought out features significant for the understanding of the nature of the liquid state. Raman and Venkateswaran[12] and Sibaiya[13] studied Brillouin scattering in crystals and determined sound velocities in them. Using the Rasetti technique, Krishnan[14] and Chandrasekharan[15] obtained some of the most interesting results in the study of Brillouin scattering in crystals. The whole program has the unmistakable stamp of Raman's inspiring leadership.

The scientific investigation of diamond was always very dear to Professor Raman. In the course of extended studies on the subject, he initiated the study of its photoconductivity,[16] luminescence[17] and infrared spectra.[18] Many of these methods were used in these investigations long before they became a standard part of solid-state spectroscopy.

It is appropriate to remark here that Raman spectroscopy has reached a new level of sophistication, thanks to the invention of lasers. Raman spectra associated with polaritons, plasmons, magnons, Landau levels and electronic levels of ions and impurities have been observed.[10] Moreover, quantitative studies of directional effects, polarization, scattering efficiency and the stimulated Raman Effect[20] have been possible with the introduction of lasers. A tunable stimulated Raman scattering from mobile carriers in semiconductors, discovered by Patel and co-workers,[21] holds a great promise for high resolution spectroscopy in the infrared. These developments came in the last decade of Raman's life; it should have brought great satisfaction to him that what started with his curiosity about the origin of the blue of the oceanic waters has grown into a rich field replete with new discoveries.

---

1. For a historical account see C. V. Raman, *Noble Lectures* (Elsevier Publishing Company, Amsterdam, 1965), *Physics,* Vol. **2**, p. 267.
2. Raman, C. V., *Molecular Diffraction of Light,* University of Calcutta, Calcutta, 1922.
3. —, *Transactions of the Faraday Society,* 1929. **25**, 781.
4. —, *Indian J. Phys.,* 1928, **2**, 387.
5. —, *Light Scattering in Spectra Solids,* Edited by G. B. Wright, Sptinger-Verlag, New York, 1969, p. XV.
6. —, and Nedungadi, T. M. K., *Nature,* 1940, **145**, 147.
7. Cochran, W., *Phys. Rev. Letters,* 1959, **3**, 412.
8. Shapiro, S. M., O'Shea, D. C. and Cummins, H. Z., *Ibid.,* 1967, **19**, 361.
9. Krishnan, R. S., *Proc. Ind. Acad. Sci.,* 1947, **26**, 399.
10. Raman, C. V. and Raghavendra Rao, B. V., *Nature,* 1935, **135**, 761; Raghavendra Rao, B. V., *Proc. Ind. Acad. Sci.,* 1934, **1**, 261.
11. —, and Venkateswaran, C. S., *Nature* 1939, **143**, 798; Venkateswaran, C. S., *Proc. Ind. Acad.* 1942, **15**, 362.
12. — and —, *Nature,* 1938, **142**, 250.
13. Sibaiya, L., *Proc. Ind. Acad. Sci.,* 1938, **8**, 393.
14. Krishnan, R. S., *Ibid.,* 1947, **26 A**, 399; *Ibid.,* 1955, **41**, 91.
15. Chandrasekharan, V., *Ibid.,* 1950, **32 A**, 379.
16. Pant, D. D., *Ibid.,* 1944, **19**, 315.
17. Nayar, P. G. N., *Ibid.,* 1941, **13**, 483.
18. Ramanathan, K. G., *Ibid.,* 1946, **24 A**, 130.
19. Porto, S. P. S., *Light Scattering Spectra of Solids,* Edited by G. B. Wright, Springer-Verlag, New York, 1969, p. 1.
20. Bloembergen, N., *Am. J. Phys.,* 1967, **35**, 989.
21. Patel, C. K. N. and Shaw, E. D., *Phys. Rev. Letters,* 1970, **24**, 451; Patel, C. K. N., Shaw, E. D. and Keil, R. J., *Ibid.,* 1970, **25**, 8.

LASER RAMAN SPECTROSCOPY OF ORGANIC COMPOUNDS

P. M. NAIR, A. P. B. SINHA AND K. VENKATARAMAN
National Chemical Laboratory, Poona-8

THE weakness of the Raman scattering and the experimental difficulties in obtaining good Raman spectra had, in the past, prevented extensive application of Raman spectroscopy in the study of organic compounds although its potentialities are at least as great as those of IR spectroscopy. The advent of continuous wave gas lasers in recent years has brought about a radical change in this situation. The difficulties and inadequacies of earlier experimental techniques have now been overcome and a great spurt of activity in the applications of Raman spectroscopy may be expected in the near future.

As compared with IR, Raman spectroscopy has a number of advantages. Glass cells and aqueous solutions may be employed. Solids may be studied directly without mulling. Unlike in IR spectroscopy, it is possible to make suitable choice of incident radiation so that the scattered radiation falls in a region which is readily observable. Moreover, depolarization measurements give additional information. However, in actual practice, it has not been possible to avail of these advantages because of the low istensity of Raman lines. In conventional Raman spectroscopy, the intense blue line of the mercury arc is generally used as the exciting radiation. As a consequence, observation of spectra is often rendered difficult by fluorescence and photo-decomposition. The photographic method has been the most widely employed for recording spectra, and with the prolonged exposures that are generally required, the large intensity of the central part of the scattered radiation, representing Rayleigh scattering, tends to smudge out Raman lines in the neighbourhood because of scattering from the photographic plate. Very often these lines are of considerable interest. For materials which absorb over very wide ranges, it is practically impossible to obtain Raman spectra in the conventional manner. These difficulties have now been overcome with the extremely high intensities obtained in laser beams. Laser beams are readily focussed on to small samples. There is no difficulty any more in recording small Raman shifts. It is now possible to study Raman spectra of even materials like graphite. Also, the line widths obtainable with lasers are about an order of magnitude smaller than for the mercury line. Spectra of very high resolution can, therefore, be obtained. A number of laser Raman spectrometers have been marketed by instrument manufacturers (Cary, Perkin-Elmer, etc.).

This revolution in instrumental technique has not yet affected organic chemistry in a big way. Nevertheless, some interesting laser Raman studies have appeared. Several unsaturated acyclic monoterpenes have been investigated and Raman intensities and depolarization ratios of C=C stretching vibrations have been discussed in terms of structural features.[1] It has been shown that 4-methyl-isochroman exhibits two conformations in the liquid state while only one is shown in the solid state.[2] It has been recognised[3] that Raman scattering of steroid derivatives is dominated by skeletal vibrations involving carbon-carbon bonds, and it has been found that polar functional groups of these molecules scatter relatively poorly. If substituent effects on the skeletal modes are small and they are analyzable as electronic and mass effects then Raman spectral data may be empirically used for recognition of ring systems. Exploratory work done in this context has already yielded useful results. Examination of a series of cedranes has shown that a set of five intense Raman bands between 500 and 900 cm^{-1} is characteristic of the cedrane skeleton.[4] Similarly, a set of seven Raman bands in the region 350 to 1100 cm^{-1} has been found to characterise a pinane ring system.[5] It has been shown[6] from laser Raman study of the longitudinal accordion motion in polymethylene liquids that the abundance of *trans* conformation falls as chain length increases. The abundance is vanishingly small for $n \geqslant 9$. A temperature study of laser Raman effect on chlorocyclopentane has shown that the barrier to pseudo-rotation in the system is at least an order of magnitude higher than previous estimates.[7] Laser Raman studies on polymers have also appeared.[8]

More active pursuit of applications of laser Raman spectroscopy in the study of structure and conformation of organic molecules may be expected very soon. Effort in this area is apparently limited at present by poor access to instruments. But this situation is bound to change with time.

1. Freeman, S. K., and Mayo, D. W., *Appl. Spect.*, 1969, 23, 610.
2. —, *Ibid.*, 1970, 24, 42.
3. Jones, R. N., *Proc. Int. Symp. Mol. Struct. Spectrox.*, Tokyo, Japan, 1962, p. A–218–1.
4. Mayo, D. W. and Freeman, S. K., *Appl. Spect.*, 1970, 24, 591.
5. Freeman, S. K. and Mayo, D. W., *Appl. Spect.*, 1970, 24, 595.
6. Schaufele, R. F., *J. Chem. Phys.*, 1968, 49, 4168.
7. Dwring, J. R., Karriker, J. M. and Wertz, D. W., *J. Mol. Spect.*, 1969, 31, 237.
8. Cain, D. S. and Harvey, A. B., In *Developments in Appl. Spectroscopy*, Vol. 7B, eds. Grove, E. L. and Perkins, A. J. Plenum Press, New York, 1970, p. 94.

STUDIES OF THE STRUCTURE AND PROPERTIES OF DIAMOND

(MISS) A. MANI

Deputy Director-General of Observatories, New Delhi-3

SIR C. V. RAMAN's interest in the beauty of the diamond and its remarkable structure and properties was a life-long involvement although in later years it was overshadowed by his love of flowers and his search for an explanation of the origin of their colours and an understanding of the physiology of vision. "Opportunities for observing the luminescence of diamond in an impressive fashion first presented themselves........in the year 1930 in connection with spectroscopic studies on the scattering of light in crystals......It was then found that the luminescence spectrum of diamond recorded itself on the spectrograms simultaneously with the scattering of light in the crystal, its leading feature being a band at 4155 Å.U. and its intensity varying enormously from specimen to specimen........The difficulty of obtaining suitable material discouraged the pursuit of the subject" (Raman, 1944). Later on, noting that "cleavage plates of diamonds of excellent quality and good size could be obtained at very modest prices and that diamond in this form was more suitable for physical investigations than the high-priced brilliants of the jeweller's trade" Sir C. V. Raman acquired a few specimens, which led to a very fruitful series of investigations on the scattering and absorption of light in diamond and its photoluminescence at various temperatures by Dr. P. G. N. Nayar (1941, 1942).

The researches of Dr. Nayar in 1941 and 1942 on the luminescence and absorption spectra of diamonds demonstrated the existence of many more vibrations of the diamond structure with discrete frequencies than the single line with a frequency shift of 1332 cm^{-1} which appears in the Raman spectrum of diamond (Ramaswami, 1930; Bhagavantam, 1930). The main results of the early investigations were summarised by Sir C. V. Raman in his Presidential Address to the Eighth Annual Meeting of the Indian Academy of Sciences at Bangalore in 1942 and published as a supplement to *Current Science* in January 1943.

In 1942, Sir C. V. Raman purchased a representative collection of diamonds mined in Panna in Central India and enlarged his collection of polished cleavage plates. The diamonds in his personal collection in 1944 numbered 310, consisting of crystals in their natural condition, polished cleavage plates and cut brilliants of both Indian and South African origin, a unique collection, probably unparalleled anywhere in a scientist's laboratory or museum. Then followed a period of intense activity when almost every student in the Physics Department was working on one aspect or other of the properties of diamond and two symposia on the structure and properties of diamond were published; again unequalled in the scope and range of the aspects studied and the results obtained.

The first symposium on diamond published in 1944 consisted of 17 papers. The first two papers on the crystal symmetry and structure of diamond, and the nature and origin of the luminescence of diamond were by Sir C. V. Raman himself. These were followed by 15 papers by his associates and pupils on the Raman spectrum of diamond, the fluorescence and absorption spectra of diamond in the visible region, the ultraviolet absorption spectrum of diamond, luminescence and birefringent patterns in diamond, the intensity of X-ray reflection by diamond, X-ray topographs of diamond, X-ray reflection and the structure of diamond, ultraviolet transparency patterns in diamond, the lattice spectrum and specific heat of diamond, the mangetic susceptibility of diamond, the photoconductivity of diamond and the crystal forms of the Panna diamond. Though the papers were by individual workers, one can see the master's hand in each, directing and guiding and finally polishing the text of each paper. His incomparable mastery of the English language, his insistence on perfection in everything one did, his vast and varied knowledge combined with an overpowering kindness and magnanimity, the identification and recognition of merit followed by encouragement and praise, often undeserved, were a continuous source of wonder to all those who had the privilege of working with him.

It was an exhilarating time, a rare experience and privilege to work in the Physics Department of the Indian Institute of Science at that time, to see the pieces falling into place and meaning appear out of the most scattered and disconnected observations, when controlled and guided by the master's hand.

The second symposium on the structure and properties of diamond appeared in 1946. This consisted of 21 papers. The first paper on the crystal forms of diamond and their significance was by Sir C. V. Raman and S. Ramaseshan. The other papers related to the second order Raman spectrum and the temperature variations of the Raman lines, the thermal expansion of diamond, the crystal symmetry of diamond and its X-ray reflections, the nature and origin of laminations in diamond, luminescence of diamond excited by X-radiation, the X-ray topographs of diamond, the cleavage properties of diamond, the Faraday effect in diamond, the absorption spectra in the ultraviolet, visible and infrared, the luminescence, phosphorescence and the thermoluminescence of diamonds and their local patterns and variations and a theory of the crystal forms of diamond.

This extensive and wide-ranging study of the physical properties of diamond involved the development of a number of new techniques of observation and measurement. Those deserving special mention are the mapping of the ultraviolet transparency and X-ray reflection intensity patterns developed respectively by Rendall and Ramachandran. Sir C. V. Raman showed that the luminescence of diamond was not as originally thought due to impurity atoms present in it but is physical in origin and fundamentally connected with the crystal structure of the diamond itself and is an inherent property of the diamond. He explained the discrete frequencies associated with the 4152 ÅU and 5032 ÅU lines appearing in fluorescence and absorption spectra by a new theory of the dynamics of the crystal lattice. He described for the first time the crystal forms of the Panna diamond and showed that,

Diamonds with tetrahedral symmetry of structure are in general blue luminescent;

Diamonds with octahedral symmetry are non-luminescent; and

Diamonds in which the tetrahedral and octahedral types of structure are intimately mixed exhibit the greenish-yellow type of luminescence. The idea that the luminescence of diamond is associated with the interpenetration of different crystal structures and the inhomogeneity resulting therefrom was furnished by X-ray studies. The non-uniformity of structure of a plate of diamond was made manifest by the luminescence patterns, ultraviolet transparency patterns, structural birefringence patterns and later by the X-ray topographs. To use his own words, "All these patterns have an eventually similar origin, *viz.*, the interpenetrative or lamellar twinning of the different possible crystal structures in diamond. The interpenetration of the positive and negative tetrahedral structures gives rise to blue luminescence without any structural birefringence, the diamond remaining ultraviolet opaque. The interpenetration of the tetrahedral and octahedral structures gives rise to the yellow luminescence accompanied by a banded structural birefringence and an imperfect ultraviolet transparency. The lamellar twinning of the two possible octahedral structures gives diamond which is both non-luminescent and ultraviolet transparent but with a characteristic finely streaky birefringence."

Writing after a visit to Panna, Sir C. V. Raman drew attention to "the remarkable beauty of the Panna crystals with their exquisitely perfect geometric forms, their smooth lustrous surfaces and the sharpness of the edges which divide the curved faces into distinct sections". We in our admiration and awe used to compare them to him, and his work, to quote his own words on Prof. S. Chandrasekhar, "bears witness to his energy, the strength and range of his scientific interests and his powers of investigation and exposition".

---

1. Raman, C. V., *Curr. Sci.*, 1942, **11**, 261.
2. —, *Ibid.*, 1943, **12**, 33.
3. —, *Proc. Ind. Acad. Sci.*, 1943, **18**, 237.
4. —, *Ibid.*, 1944, **19**, 189.
5. —, *Ibid.*, 1944, **19**, 214.
6. — and Rendall, G. R., *Ibid.*, 1944, **19**, 265.

7. Raman, C. V. and Rendall, G. R., *Proc. Ind. Acad. Sci.*, 1964, 24, 168.
8. — and Ramaseshan, S., *Ibid.*, 1946, **24**, 1.
9. Ramaswamy, C., *Nature*, 1930, 125, 704.
10. —, *Ind. Journ. Phys.*, 1930, 5, 97.
11. Bhagavantam, S., *Ibid.*, 1930, 5, 169.
12. John, M. V., *Ibid.*, 1931, 6, 305.
13. Nayar, P. G. N., *Proc. Ind. Acad. Sci.*, 1941, **13**, 284.
14. —, *Ibid.*, 1941, 13, 483.
15. —, *Ibid.*, 1941, 13, 534.
16. —, *Ibid.*, 1941, 14, 1.
17. —, *Ibid.*, 1942, 15, 293.
18. —, *Ibid.*, 1942, 15, 310.
19. Krishnan, R. S., *Ibid.*, 1944, **19**, 216.
20. Dayal, B., *Ibid.*, 1944, 19, 224.
21. Mani, A., *Ibid.*, 1944, 19, 231.
22. —, *Ibid.*, 1944, 20, 117.
23. —, *Ibid.*, 1944, 20, 155.
24. —, *Ibid.*, 1944, 20, 323.
25. —, *Ibid.*, 1945, 21, 280.
26. Sunanda Bai, K., *Ibid.*, 1944, 19, 253.
27. —, *Ibid.*, 1944, 19, 274.
28. Hariharan, P. S., *Ibid.*, 1944, **19**, 261.
29. Ramachandran, G. N., *Ibid.*, 1944, **19**, 279.
30. Rendall, G. R., *Ibid.*, 1944, 19, 293.
31. Krishnan, R. S., *Ibid.*, 1944, **19**, 298.
32. Ramachandran, G. N., *Proc. Ind. Acad. Sci.*, 1944, 19, 304.
33. Sigamany, A., *Ibid.*, 1944, **19**, 310.
34. Pant, D. D., *Ibid.*, 1944, 19, 315.
35. —, *Ibid.*, 1944, 19, 325.
36. Ramaseshan, S., *Ibid.*, 1944, 19, 334.
37. Krishnan, R. S., *Ibid.*, 1946, 24, 25.
38. —, *Ibid.*, 1946, 24, 33.
39. —, *Ibid.*, 1946, 24, 45.
40. Ramachandran, G. N., *Ibid.*, 1946, **24**, 58.
41. —, *Ibid.*, 1946, 24, 65.
42. —, *Ibid.*, 1948, 24, 81.
43. —, *Ibid.*, 1946, 24, 95.
44. Ramaseshan, S., *Ibid.*, 1946, 24, 104.
45. —, *Ibid.*, 1946, 24, 114.
46. —, *Ibid.*, 1946, 24, 122.
47. Ramanathan, K. G., *Ibid.*, 1946, **24**, 130.
48. —, *Ibid.*, 1946, 24, 137.
49. —, *Ibid.*, 1946, 24, 145.
50. —, *Ibid.*, 1946, 24, 151.
51. Achyuthan, K., *Ibid.*, 1946, 24, 162.
52. Rendall, G. R., *Ibid.*, 1946, 24, 168.
53. Ramachandran, G. N. and Chandrasekharan, V. *Ibid.*, 1946, 24, 176.
54. Chandrasekharan, V., *Ibid.*, 1946, 24, 182.
55. —, *Ibid.*, 1946, 24, 187.
56. —, *Ibid.*, 1946, 24, 193.

SPECTROSCOPIC STUDIES ON DIAMOND BY RAMAN AND HIS GROUP

R. K. ASUNDI

Spectroscopy Division, BARC, Bombay-85

AND

D. D. PANT

Government D.S.B. College, Nainital, Uttar Pradesh

INTRODUCTION

SIX years after the publication of the historical paper on two types of diamonds by Robertson, Fox and Martin,[1] a short note on "A New X-Ray Effect" in *Current Science* by Professor Raman[2] heralded an era of extensive researches on diamond by him and his group. These studies lasted over two decades till Raman's fascination for the physics of colour and vision became his more dominant interest. The researches have been published in various issues of the *Proceedings of the Indian Academy of Sciences* including two symposia,[3,4] several memoirs of the Raman Research Institute[5] and a comprehensive article.[6] Occasionally, a few papers have appeared elsewhere[7] also.

The new dynamic X-ray reflection was shown by Type I diamonds only and was suggested to be a consequence of excitation of the high frequency infrared optical mode by X-ray photon. If diamond structure has full holohedral symmetry (Oh), this mode ($\nu = 1332\ \text{cm}^{-1}$) should be Raman-active and I.R.-inactiv However, Type I diamonds absorb in the fundamental region (6 to 13 μ) though Type II d not. There are, besides, several contrastin properties of the two types, *e.g.*, U.V. absorption, luminescence, birefringence, photoconductivity, etc. Thus, Type I diamonds absorb below 3000 Å, while Type II are transpare upto 2250 Å. Similarly, Type I show fluorescence while Type II are non-luminescent. Th Bangalore group studied and correlated th diverse properties by studying a large numbe of diamonds of various origins (over 300) i the collection of Prof. Raman.

DIAMOND PATTERNS

Besides spectroscopic studies in the conventional way, luminescence patterns under nea U.V. excitation, U.V. transparency patterns an birefringence patterns of hundreds of diamonds were photographed by Rendall, Ba Jayaraman and Ramachandran. Beside X-ray topographs, infrared transparency patterns and phosphorescence patterns were al taken by Ramachandran, Ramanathan and Chandrasekhar respectively. As a result of these studies, it was found that only a small percentage of diamonds was of Type A (Type I) and another small percentage of Type B (Type II) while a large majority of diamonds was of composite nature. The A group diamonds were isotopic, optically perfect, opaque to U.V. and blue luminescent. The group B diamonds were visibly birefringent, transparent to U.V. and non-luminescent.

U.V. AND I.R. ABSORPTION SPECTRA

In addition to the already known facts, Bai, Mani and Ramanathan showed that several selective U.V. absorption bands, some of them quite sharp, appear upon the strong background. The I.R. spectra were studied by Ramanathan and later by Raman himself. In the fundamental region bands at 1332, 1273, 1219, 1176, 1087, 1010, 746 and 624 cm^{-1} with degeneracies 3, 8, 6, 4, 6, 4, 6 and 8 respectively were identified as the 45 modes of atomic vibration of diamond lattice in accordance with Raman's theory of lattice vibrations. Raman suggested that the contrasting behaviour of I.R. absorption and other properties was a result of fundamental difference in lattice structure ; carbon atoms in two Bravais lattices in diamond give rise to tetrahedral, or octahedral structures. Raman's class A are tetrahedral diamonds while class B octahedral. These two, however, are limiting cases. The octahedral diamonds are transparent in 6-13 μ region while the absorption in the 3-6 μ region by all diamonds, according to Raman, is a second order process. The Raman scattering experiments by Krishnan employing Rasetti technique with 2536 Å radiation showed occurrence of the well-known 1332 cm^{-1} line besides additional Raman lines, with frequency shifts 1925, 2175·5, 2245, 2267, 2300·5, 2495, 2518, 1609·5 and 2664·6 cm^{-1}. These lines were identified as octaves or allowed combinations of the eight fundamental frequencies of diamond lattice mentioned above.

THE 4152 Å AND 5032 Å SYSTEMS

Most of the Type A and composite diamonds emit two systems of bands with their principal absorption and emission lines at 4152 Å and 5032 Å respectively. However, not only their absolute intensities but also their relative intensities vary within wide limits. Nayar and later Mani made a detailed study of these emissions and were the first to observe the fine structure associated with them. The principal line is accompanied in the 4152 Å system by a large number of subsidiary lines which are due to lattice vibrations superposed on the main electronic transition. The absorption and excitation spectra are complementary. The 5032 Å system has, however, more continuous background but has similar structure. Ramachandran and Chandrasekhar obtained an emission line in diamond at 7930 Å while Pant found a qualitative inverse relation between photoconductivity and luminescence.

The luminescence was attributed to inherent structure of diamond. If positive and negative tetrahedral structures co-exist interpenetrating each other, blue luminescence arises while if tetrahedral and octahedral structures co-exist, blue and green luminescence arises. Raman completely discarded the impurity origin of luminescence.

IMPURITY ORIGIN OF THE SPECTROSCOPIC PROPERTIES OF DIAMOND

Diamonds are now classified as Type I *a*, I *b*,[8] II *a* and II *b*.[9] Type I *b* are mostly synthetic diamonds with I.R. and U.V. absorption supposed to be due to dispersed nitrogen. Type II *b* are semiconducting diamonds. The I.R. absorption in the 3-6 μ region is a second order process hence exists in all diamonds.[10] U.V. and I.R. absorption (6-13 μ) in Type I, however, was shown to be due to nitrogen impurity.[11] More recent work shows that nitrogen occurs both in dispersed form showing nitrogen e.p.r. and in segregated layer configurations. A critical examination of the nitrogen centres and their role in I.R. and U.V. spectra is given by Sobolev *et al.*[12] The edge emission spectra and related topics in diamond have been reviewed by Dean[13] who has also given an account of various other new systems observed in emission. The 4152 Å system of Nayar is a Mössbauer type emission with zero-phonon line possibly due to N-Al pair. The 5032 Å system of Nayar and Mani is believed to have a different origin[14] and can be induced in Type I by heat treatment after pile or electron irradiation.[15]

---

1. Robertson, Fox and Martin, *Phil. Trans.*, 1934, 232, 494.
2. Raman, *Curr. Sci.*, 1940, 9, 165.
3. First symposium on diamond, *Proc. Ind. Acad. Sci.*, 1944, 19 A.
4. Second symposium on diamond, *Ibid.*, 1946, 24.
5. Raman, *Memoirs Nos. 104, 109, 129 of Raman Research Institute.*
6. —, *Proc. Ind. Acad. Sci.*, 1968, 67 A, 231.
7. —, *Rev. Roumaine Phys.*, 1968, 13, 7.

8. Dyer and Raal, *Phil. Mag.*, 1965, **11**, 763.
9. Custers, *Physica*, 1952, **18**, 489.
10. Lax and Burstain, *Phys. Rev.*, 1955, **97**, 39.
11. Kaiser and Bond, *Ibid.*, 1959, **115**, 857.
12. Sobolev, Il'in, Gil'bert and Lenskaya, *Soviet Phys. Solid State*, 1969, **11**, 200 (247 Russ.).
13. Dean, *Luminescence of Inorganic Solids*, Editor Paul Goldberg, Academic Press, 1966, p. 11
14. Runciman, *Proc. Phys. Soc.*, 1965, **86**, 629.
15. Dyer and Mathews, *Proc. Roy. Soc.*, 1957, **243 A** 320.

SOME RESULTS IN NON-LINEAR VIBRATION OF STRETCHED STRINGS

B. S. RAMAKRISHNA AND G. V. ANAND
Indian Institute of Science, Bangalore

FOR more than two thousand years, the vibrations of stretched strings fascinated mathematicians, physicists and musicians alike. Pythagoras, Euler, D'Alembert, Helmholtz, Raman and many others made significant contributions to our knowledge of their behaviour. Conceptually simple and elegant, the vibration of a stretched string served as a mathematical model for our understanding of intuitively less tractable notions like electromagnetic waves and atomic wave functions when they were first conceived. The study of vibrations of strings of musical instruments not only marked the beginning of Raman's scientific work, but remained close to his heart throughout his long scientific career. It embodies in a sense his ethos of scientific work, *viz.*, simplicity of experimentation which marked all his work. It is in this spirit that we summarize here some recent results obtained on the non-linear behaviour of strings at the Indian Institute of Science,[1–5] of which he was the head for several years.

Resonance Response of Stretched Strings

If a stretched string is driven by a harmonic force F cos ωt in the xy plane as shown in Fig. 1, the classical theory tells us that the string would vibrate in the xy plane and its frequency response would be as given by the curve AR..ST of Fig. 2. As a resonance frequency of the string is approached, the amplitude would grow to infinite values but for some amount of damping that is always present.

Actually, experiment reveals something entirely different. It is extremely simple to obtain the frequency response of a string by applying a constant magnetic field in a horizontal direction at right angles to the string and passing an alternating current from an oscillator of variable frequency. A force F cos ωt then acts in the vertical or y-direction and the amplitude of the string can be measured with a microscope. If we start a little below a resonance frequency ω_n and slowly increase the frequency of the driving force, we find that the amplitude follows the curve AB in the beginning but before approaching the resonance it takes a path like APG....After reaching some point G on this curve, the amplitude suddenly falls down to the point E on the curve ST obtained from the linear theory and then continues on this curve. If the frequency ω of the driving force is decreased now, the amplitude does not retrace the path TEGPA, but follows the path TED'B'PA At the point D' the amplitude suddenly jumps to the point B' after which the original curve B'PA is retraced.

In addition to the jumps in amplitude exhibited by the frequency response curve, the motion of the string ceases to remain in the plane of the driving force (the xy plane) when a certain critical amplitude is reached. A some point P along the curve the string acquires a component of vibration in the perpendicular plane xz. This z-component of vibration increases continuously along with the y-component. The motion of the string which is planar until this stage becomes gradually whirling, non-planar motion until the jum occurs at G, after which it becomes plana again. If the frequency of the driving forc is decreased, the non-planar motion reappear after the upward jump takes place at D Unless the string is heavily damped, the non-planar motion and the jumps near the resonance frequency are always observed, however small the driving force may be. Thes are typical non-linear features which the classical theory cannot explain even qualitativel

Non-Linear Equations of Motion

Beginning with Carrier, the non-linear equations of motion of a string have been writte down to different degrees of generality b several investigators. They differ essential from the usual linear equations in considering a deformation of an element of the string into a space curve (instead of a plane curve as is normally done) and taking into account the local change in tension arising from an increase in the length of the element in accordance with Hooke's law. The momentum equations in the x, y and z directions lead to

$$u_{tt} = c_1^2 u_{xx} + c_1^2 \frac{\partial}{\partial x}\{\tfrac{1}{2}(y_x^2 + z_x^2)\}, \tag{1}$$

$$y_{tt} = c_0^2 y_{xx} + c_1^2 \frac{\partial}{\partial x}\{[u_x + \tfrac{1}{2}(y_x^2 + z_x^2)]y_x\}, \tag{2}$$

$$z_{tt} = c_0^2 z_{xx} + c_1^2 \frac{\partial}{\partial x}\{[u_x + \tfrac{1}{2}(y_x^2 + z_x^2)]z_x\}, \tag{3}$$

where u is the longitudinal displacement, y and z are transverse displacements, $c_0 = (T/m)^{\frac{1}{2}}$ is the linear transverse velocity and $c_1 = (EA/m)^{\frac{1}{2}}$ is the linear longitudinal velocity. The first terms on the right-hand side of (1), (2) and (3) represent the usual linear equations of longitudinal and transverse motions. The second terms represent the coupling that arises between the longitudinal and transverse motion as well as between the two components of the transverse motions.

SOLUTIONS OF FORCED MOTION

The last term on the right-hand side of Eqn. (1) represents an effective longitudinal force. Since, in most cases of practical interest, the fundamental longitudinal resonance frequency is small compared to the fundamental transverse resonance frequency, the frequency of the effective longitudinal force is normally well below the fundamental longitudinal resonance frequency. The term u_{tt} in Eqn. (1) can, therefore, be ignored. This approximation facilitates separating the equations for longitudinal and transverse modes. However, the equations for the mutually perpendicular transverse vibrations cannot be separated.

The harmonic response to a simple harmonic driving force of frequency ω acting in the xy plane can now be considered. For simplicity, we assume that the fundamental linear resonance frequency is unity and we seek solutions for the case $\omega \simeq 1$. Assuming the solutions

$$y = A_y \cos \omega t,$$
$$z = A_z \cos(\omega t + \beta), \tag{4}$$

substituting into the equations of motion, and applying the principle of harmonic balance, it is found that two distinct solutions are possible. These are

$$\eta A_y^3 - (\omega^2 - 1) A_y = F,$$
$$A_z = 0, \tag{5}$$

corresponding to a planar motion in the plane of the driving force and

$$\eta A_y^3 - \tfrac{3}{4}(\omega^2 - 1) A_y = \tfrac{9}{8} F,$$
$$\eta A_z^2 = \omega^2 - 1 - \frac{1}{3}\eta A_y^2, \quad \beta = \frac{\pi}{2}, \tag{6}$$

corresponding to elliptical motion. The parameter η appearing in Eqns. (5) and (6) is a parameter of non-linearity.

The y-response curves ($|Ay|$ *vs.* ω) for the two types of motion are shown in Fig. 3. The curve APB....CDE is the response curve for planar motion and A′PB′...C′D′E′ corresponds to non-planar motion. From the second of Eqns. (6), it is evident that non-planar motion can exist only if $\eta A_y^2 < 3(\omega^2 - 1)$. The boundary curve corresponding to

$$\eta A_y^2 = 3(\omega^2 - 1) \tag{7}$$

is shown as QPF in Fig. 3. Non-planar motion cannot exist to the left of this curve. Hence, for a given amplitude of the driving force, as the driving frequency ω is increased, the response must remain planar until the curve QPF is reached. To the right of QPF, the response may be either planar or non-planar. However, an analysis of stability shows that planar motion is unstable in the region bounded by the curves QPF and QDH in Fig. 3, while non-planar motion is stable only in the region bounded by the curves QPF and QG. The equations of the curves QG and QDH are respectively

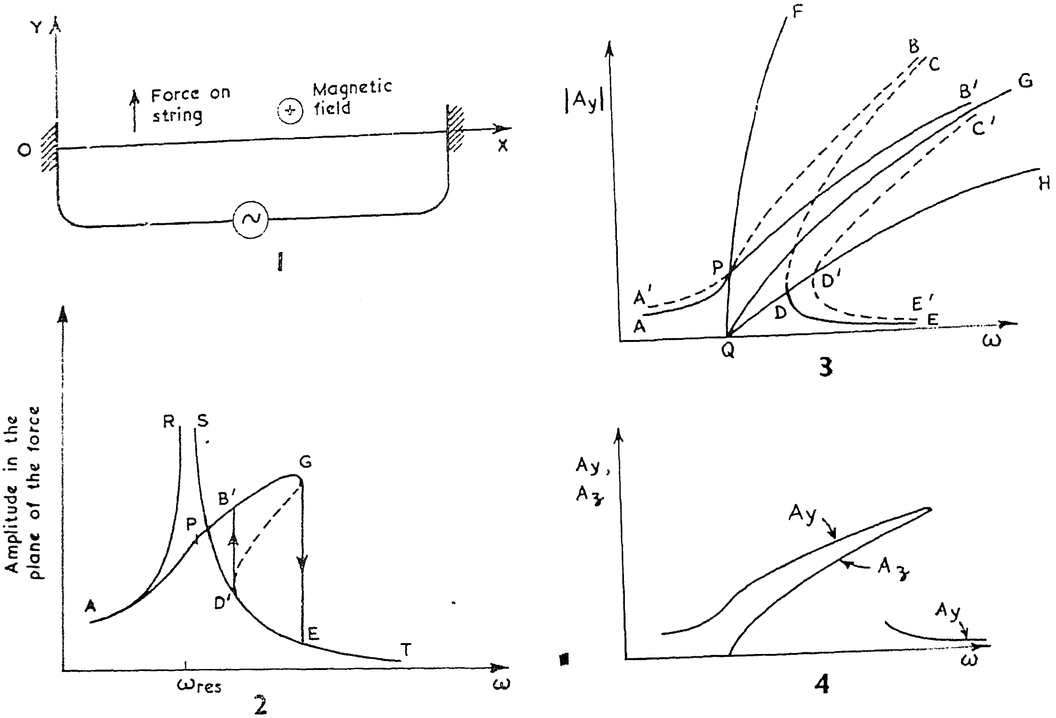
$$\eta A_y^2 = \tfrac{3}{4}(\omega^2 - 1), \tag{8}$$

and

$$\eta A_y^2 = \tfrac{1}{3}(\omega^2 - 1). \tag{9}$$

Hence, as the frequency is increased from a small value, the response curve actually traced is APB′. Due to the damping which is always present, the branches PB′ and D′C′ do not extend indefinitely but meet at some point close to QG. A downward jump in amplitude occurs at this point of intersection. This jump is accompanied by a transition to planar motion since non-planar motion is unstable below the curve QG. A decrease in frequency after the downward jump causes the response to increase along the curve ED until the point D is reached. At this point, the planar motion becomes unstable and an upward jump in amplitude occurs accompanied by a transition to non-planar motion.

The behaviour of the amplitude A_z with frequency is shown in Fig. 4. It is seen that A increases with ω more rapidly than A_y and just before the downward jump A_y and A_z are almost equal.



FIGS. 1–4

A theoretical analysis taking damping into account shows that the resonance frequency of the string is not a constant of the system as predicted by the linear theory, but increases with the driving force. Also, it can be shown that below a critical driving force, non-planar vibrations cannot exist. This critical driving force is very nearly proportional to the cube of the damping factor.

FREE OSCILLATIONS

Analysis of the problem of free non-linear vibrations of the string also yields many interesting results. While the analysis for the most general initial conditions is very complicated all the salient features of non-linear behaviour can be brought out by studying the case of sinusoidal initial conditions. An approximate solution of this case can be obtained by assuming the amplitude and phase to be slowly varying functions of time. Such an analysis (ignoring damping) shows that A_y^2 and A_z^2 are sinusoidally varying functions of time.

$$A_y^2 = a_1^2 + a_2^2 \sin(pt + \phi),$$
$$A_z^2 = a_1^2 - a_2^2 \sin(pt + \phi), \qquad (10)$$

where a_1^2, a_2^2, p and ϕ are functions of the initial values. Further, p is proportional to the non-linearity parameter which means that p is very small compared to the natural frequency of the string if the non-linearity is small. Equations (10) can be interpreted as representing an oscillation of part of the energy of vibration between the y and z components while the total energy remains constant. Also, the average energy of both components is equal and independent of the initial distribution of energy. It follows that the string cannot execute planar free vibrations since the quantity a_2 [appearing in Eqn. (10)] can never be made zero for any set of initial values. In fact, a stability analysis shows that the only stable periodic mode of vibration is the circular mode in which each point on the string describes a circle in the YZ plane. In general, the locus of a point on the string is an ellipse with slowly rotating axes, The results mentioned above, some of which are quite striking, bring into sharp focus the changes introduced by non-linearity.

1. Murthy, G. S. S. and Ramakrishna, B. S., *J. Acoust. Soc. Amer.*, 1965, **38**, 461.
2. Anand, G. V., *J. Acoust. Soc. Amer.*, 1966, **40**, 1517.
3. Narasimha, R., *J. Sound Vibration*, 1968, **8**, 134.
4. Anand, G. V., *J. Acoust. Soc., Amer.*, 1969, **45**, 1089.
5. —, *Ibid.*, 1969, 46, 667.

SOME REFLECTIONS ON PROFESSOR RAMAN

A. JAYARAMAN
National Aeronautical Laboratory, Bangalore-17
and
Bell Telephone Laboratories, New Jersey, U.S.A.

I HAD the privilege of being associated with Prof. Raman for over a decade from 1949-60. This was a period in which his great dream of establishing an independent research institute took the final shape. He devoted all his energy and time to the fulfilment of this dream. The building was just about ready in 1949 and the immediate task was to arrange the priceless crystals and mineral specimens that he had acquired. Soon began the flow of scientific apparatus and research students into the laboratory and the Raman Research Institute became an active centre for research. Professor Raman never stopped acquiring crystal specimens, nor building up the library. On both these counts he was lavish. Until death he was passionately involved in scientific research and towards the end he made inroads into fields of activity, conventionally not regarded as physics. But to him boundaries in science were artificial. Throughout his life, colour and order in Nature dominated his thought.

Professor Raman's love for crystals is universally known. There are very few scientific men in India who have not at one time or other seen his exquisite collection. The crystallographic and mineralogical museum at the Raman Research Institute is probably one of its kind in Asia and had a dual purpose. The specimens were not only for display but also meant for research. Professor Raman had an insatiable curiosity to understand crystal optical phenomena and was very much attracted by gems and gemstones. During my stay I had the privilege of assisting him in many of the optical and X-ray studies on gemstones. He had a fascination for opals, labradorite and moonstones. He explained the origin of the optical effects exhibited by iridescent feldspars, opals and agates and his researches on diamond are widely known. These studies fill volumes and have been issued as Memoirs of the Raman Research Institute.

He often worked with very simple equipment. For instance, when he needed a powerful beam of light he always turned to the sun. It took a year-and-a-half after I joined, to bring electricity to the Institute. This did not deter Professor Raman from doing research. A pair of polaroids, a heliostat to reflect the sunlight, a pocket spectroscope, an optical cell and a darkened room, were all that he needed to start a study of even the most complex optical phenomena.

For us the most enjoyable and rewarding moments were those when we were closeted with him, while he was making some observations and thinking aloud. During those moments, the most abstruse optical principles became crystal clear to us, an education that cannot come studying voluminous treatises on the subject. As his students and associates, we not only benefited by his guidance and suggestions in relation to a particular problem, but more importantly, we learnt the methodology of research. He advocated that if a particular problem was interesting, one should straight plunge into it irrespective of what other investigators have said or found. An unprejudiced mind can unearth something new, since each individual looks at a problem from a different angle. Time and again this has proved to be true within my own experience.

A year ago, I heard a talk by a senior colleague of mine in Bell Laboratories and the title was, "How to do Nobel Prize Winning Work", indeed a most unusual title for a talk. It was a very interesting lecture and the prescriptions were not that simple. The lecturer surveyed the work and personal characteristics of many Nobel Prize winners and brought out the following points: (1) These men were determined to get the highest honour a scientist can aspire for and were strongly motivated towards their goal. (2) They chose areas of research which were ripe for discoveries. (3) They anticipated the results, wrote even the papers beforehand and did the experiments to fill the blanks. (4) They persisted until success was achieved. (5) They knew the art of selling their product, *viz.*, their discovery, and had the gift of writing and speech, the two important elements necessary to convert the scientific audience to their way of thinking." Professor Raman once told me that when a lecture is delivered, the audience must be under the delusion that they have understood everything that was said, and if one cannot explain one's work in a few sentences without bringing in esoteric formulae, it is not worth knowing. When I heard the above-mentioned talk by my Bell Laboratories colleague, it struck me that it all made sense. I have been in closest touch with one such giant of a personality and every point mentioned stood before me as familiar knowledge.

PROF. RAMAN ON THE RAMAN RESEARCH INSTITUTE

S. RAMASESHAN

National Aeronautical Laboratory, Bangalore-17

SEVERAL times Prof. Raman has talked to me of the future of Raman Research Institute. He did this again between the 10th and 19th of November, only a few days before he died. I thought it may be worthwhile to record some of his thoughts which I noted down at that time. They are almost in his own words.

"The Raman Research Institute was created by me in 1948 to provide a place in which I could continue my studies in an atmosphere more conducive to pure research than that found in most scientific institutions. To me the pursuit of science has been an aesthetic and joyous experience. The Institute has been to me a haven where I could carry on my highly personal research work.

"This personal character of the Raman Research Institute should obviously change after me. It must blossom into a great centre of learning embracing many branches of science. Scientists from different parts of India and from all over the world must be attracted to it.

"The foundations of such a centre have already been laid. With its beautiful gardens, large libraries and extensive museums, I feel that the Institute offers a perfect nucleus for the growth of a centre of higher learning.

"I have always felt that science can only flower out when there is an internal urge. It cannot thrive under external pressures. I strongly believe that fundamental science cannot be driven by instructional, industrial, governmental or military pressures. This was the reason why I decided, as far as possible, not to accept money from Government.

"I am a very practical man and I am practical enough to see that it would not be possible for others to run or grow a good institution without funds. I have bequeathed all my property to the Institute. Unfortunately, this may not be sufficient for the growth of this centre of learning. I, therefore, will not put it as a condition that no Governmental funds should be accepted by the Institute. I would, however, strongly urge taking only funds that have no strings attached.

"The full potential of this centre of learning can only be achieved by exceptional leadership. Among the many qualities called for in a person who assumes this responsibility are scientific integrity, vision, receptiveness to new ideas and the enlightened outlook to let younger people grow unhindered to their full height. If these qualities can also be combined with the scientific reputation acquired by significant personal contributions in a chosen field of endeavour one has the leader who is likely to succeed in developing the Institute and incidentally rendering the nation a service. Any person who assumes the responsibility of running the Institute must have full control of the laboratories, libraries, workshops and other facilities. He must be empowered to acquire and dispense money in the name of the Institute. He must have powers to appoint or terminate the services of personnel required for the running of the Institute. Nothing is so detrimental to the growth of science in an institution than the existence of dead-wood floating aimlessly which cannot participate in the scientific growth of an institute."

BIBLIOGRAPHY OF PAPERS BY SIR C. V. RAMAN, PUBLISHED IN *CURRENT SCIENCE* (Cited in Chronological Order)

1. A New X-Ray Effect (co-author P. Nilakantan), 1940, **9**, 165.
2. The Phenomena of Conical Refraction, 1942, **11**, 44.
3. New Concepts of the Solid State, 1942, **11**, 85.
4. Spectroscopic Investigation of the Solid and Liquid States, 1942, **11**, 225.
5. The Physics of the Diamond, 1942, **11**, 261.
6. The Nature of the Liquid State, 1942, **11**, 303.
7. Newton and the History of Optics, 1942, **11**, 453.
8. The Structure and Properties of Diamond, 1943, **12**, 33.
9. Astronomical Research in India : I, 1943, **12**, 197.
10. Astronomical Research in India : II, 1943, **12**, 289.
11. Astronomical Research in India : III, 1943, **12**, 313.
12. The Four Forms of Diamond, 1944, **13**, 145.
13. Centenary of the Faraday Effect, 1945, **14**, 281.
14. The Diamond and its Teachings, 1946, **15**, 205.
15. New Concepts of Crystal Structure, 1946, **15**, 329.
16. New Paths in Crystal Physics, 1947, **16**, 67.
17. The Infra-red Spectrum, 1947, **16**, 359.
18. The Eigenvibrations of Crystal Structures, 1948, **17**, 1.
19. Dynamic X-Ray Reflections in Crystals, 1948, **17**, 65.
20. The Iridescent Feldspars, 1950, **19**, 301.
21. The Luminescence of Diamond : I, 1950, **19**, 301.
22. The Luminescence of Diamond : II, 1951, **20**, 1.
23. The Luminescence of Diamond : III, 1951, **20**, 27.
24. The Luminescence of Diamond : IV, 1951, **20**, 55.
25. More about the Iridescent Feldspars, 1951, **20**, 85.
26. The Structure and Optical Behaviour of the Ceylon Moonstones (co-authors : A. Jayaraman and T. K. Srinivasan), 1951, **20**, 96.
27. Iridiscent Crystals (co-author : D. Krishnamurti), 1952, **21**, 327.
28. The Christiansen Experiment (co author : M. R. Bhat), 1953, **22**, 31.
29. Optics of the Pearl (co-author : D. Krishnamurti), 1954, **23**, 173.
30. Amethyst : Its Nature and Origin, 1954, **23**, 379.
31. The Elasticity of Crystals, 1955, **24**, 325.
32. The Thermal Energy of Crystals, 1955, **24**, 357.
33. X-Rays and Crystals, 1955, **24**, 395.
34. Quantum Theory and Crystal Physics, 1956, **25**, 377.
35. The Specific Heats of Crystalline Solids : Part I, 1957, **26**, 195.
36. The Specific Heats of Crystalline Solids : Part II, 1957 **26**, 231.
37. Science in Eastern Europe : I, 1958, **27**, 371.
38. Science in Eastern Europe II, 1958, **27**, 421.
39. Percussion Figures in Crystals, 1959, **28**, 1.
40. Christiaan Huyghens and the Wave Theory of Light, Part I, 1959, **28**, 49.
41. Christiaan Huyghens and the Wave Theory of Light, Part II, 1959, **28**, 95.
42. The Principle of Huyghens and the Diffraction of Light, 1959, **28**, 267.
43. The Optics of Mirages, 1959, **28**, 309.
44. Light, Colour and Vision, 1959 **28**, 429.
45. On the Sensations of Colour and the Nature of the Visual Mechanism, 1960, **29**, 1.
46. The Role of the Retina in Vision, 1962, **31**, 315.
47. The Luminescence of Fluorspar, 1962, **31**, 361.
48. The Infra-red Behaviour of Diamond, 1962, **31**, 403.
49. The Two Species of Fluorite, 1962, **31**, 445.
50. Light, Colour and Vision, 1962, **31**, 489.
51. The Infra-red Behaviour of the Alkali Halides, 1963, **32**, 1.
52. Floral Colours and their Spectral Composition, 1963, **32**, 147.
53. The Trichromatic Hypothesis, 1963, **32**, 245.
54. Floral Colours and the Physiology of Vision, 1963, **32**, 293.
55. The Green Colour of Vegetation, 1963, **32**, 341.
56. The Visual Pigments and their Location in the Retina, 1963, **32**, 389.
57. The Colours of Gemstones, 1963, **32**, 437.
58. Visual Acuity and its Variations, 1963, **32**, 531.
59. Fluctuations of Luminosity in Visual Fields, 1964, **33**, 65.
60. The Visual Synthesis of Colour, 1964, **33**, 97.
61. Stars, Nebulae and the Physiology of Vision, 1964, **33**, 293.
62. The Scintillation of the Stars, 1964, **33**, 355.
63. The New Physiology of Vision : Chapter I. Introductory, 1964, **33**, 541.
64. The New Physiology of Vision : Chapter II, Visual Sensations and the Nature of Light, 1964, **33**, 571.
65. The New Physiology of Vision : Chapter III. Corpuscles of Light and Perception of Luminosity, 1964, **33**, 603.
66. The New Physiology of Vision : Chapter IV. Corpuscles of Light and Perception of Forms, 1964, **33**, 635.
67. The New Physiology of Vision : Chapter V. Corpuscles of Light and Perception of Colour, 1964, **33**, 667.
68. The New Physiology of Vision : Chapter VI. Vision in Dim Light, 1964, **33**, 699.
69. The New Physiology of Vision : Chapter VII. The Perception of Colour in Dim Light, 1964, **33**, 733.
70. The New Physiology of Vision : Chapter VIII. The Perception of Polarised Light, 1965, **34**, 1.
71. The New Physiology of Vision : Chapter IX. The Structure of the Fovea, 1965, **34**, 37.
72. The New Physiology of Vision : Chapter X. The Major Visual Pigments, 1965, **34**, 69.

73. The New Physiology of Vision: Chapter XI. The Carotenoid Pigments, 1965, 34, 103.
74. The New Physiology of Vision: Chapter XII. Chromatic Sensations at High Luminosities, 1965, 34, 135.
75. The New Physiology of Vision: Chapter XIII. Blue, Indigo and Violet in the Spectrum, 1965, 34, 167.
76. The New Physiology of Vision: Chapter XIV. The Red End of the Spectrum, 1965, 34, 199.
77. The New Physiology of Vision: Chapter XV. The Chromatic Responses of the Retina, 1965, 34, 233.
78. The New Physiology of Vision: Chapter XVI. Further Studies of the Retinal Responses, 1965, 34, 269.
79. The New Physiology of Vision: Chapter XVII. Location of Visual Pigments in the Retina, 1965, 34, 303.
80. The New Physiology of Vision: Chapter XVIII. The Visual Synthesis of Colour, 1965, 34, 333.
81. The New Physiology of Vision: Chapter XIX. Perception of Colour and the Trichromatic Hypothesis, 1965, 34, 363,
82. The New Physiology of Vision: Chapter XX. Superposition and Masking of Colours, 1965, 34, 391.
83. The New Physiology of Vision: Chapter XXI. The Green Colour of Vegetation, 1965, 34, 419.
84. The New Physiology of Vision: Chapter XXII. Colours of Flowers, 1965, 34, 445.
85. The New Physiology of Vision: Chapter XXIII. The Colours of Roses, 1965, 34, 471.
86. The New Physiology of Vision: Chapter XXIV. Floral Pigments and the Perception of Colour, 1965, 34, 45.
87. The New Physiology of Vision: Chapter XXV. The Colours of Natural and Synthetic Gemstones, 1965, 34, 521.
88. The New Physiology of Vision: Chapter XXVI. Structural Colours, 1965, 34, 547.
89. The New Physiology of Vision: Chapter XXVII. The colours of Thin Films, 1965, 34, 573.
90. The New Physiology of Vision: Chapter XXVIII. Observations with a Neodymium Filter, 1965, 34, 599.
91. The New Physiology of Vision: Chapter XXIX. Reproduction of Colour, 1965, 34, 625.
92. The New Physiology of Vision: Chapter XXX. The Photo-Mechanical Reproduction of Colour, 1965, 34, 653.
93. The New Physiology of Vision: Chapter XX The Integration of Colour by Retina, 19 34, 679.
94. The New Physiology of Vision: Chapter XXX Defects in Colour Vision, 1966, 35, 1.
95. The New Physiology of Vision: Chapter XXX The Testing of Colour Vision, 1966, 35,
96. The New Physiology of Vision: Chapter XXX The Nature and Origin of Defects in Col Vision, 1966, 35, 55.
97. The New Physiology of Vision: Chapter XX The Faintest Observable Spectrum, 1966, 83.
98. The New Physiology of Vision: Chapter XXX The Postulated Duality of Retina, 1966, 111.
99. The New Physiology of Vision: Chapter XXX The Spectrum of the Night Sky, 1966, 137.
100. The New Physiology of Vision: Cha XXXVIII. The Adaptation of Vision to I Light, 1966, 35, 165.
101. The New Physiology of Vision: Cha XXXIX. Daltonian Colour Vision, 1966, 193.
102. The New Physiology of Vision: Cha XL. The Colours of Iolite, 1966, 35, 221
103. The New Physiology of Vision: Cha XLI. Photography in Colour, 1966, 35,
104. The New Physiology of Vision: Cha XLII. Further Observations with the N dymium Filter, 1966, 35, 271.
105. The New Physiology of Vision: Cha XLIII. The Colours of Fluorspar, 1965, 297.
106. Zonal Winds and Jet-Streams in the At sphere, 1967, 36, 593.
107. The Atmsophere of the Earth, 1968, 37,
108. The Diamond: Its Structure and Proper 1968, 37, 211.
109. The Diamonds of the Krishna Valley, 1 37, 541.
110. Floral Colours and Their Origin, 1969, 179.
111. The Florachromes: Their Constitution Optical Behaviour, 1969, 38, 451.
112. The Colours of Roses, 1969, 38, 503.
113. Spectrophotometry of Floral Extracts, 1969, 527.
114. Blue Delphiniums and the Purple Big 1969, 38, 553.
115. The Varied Colours of Verbena, 1969, 38,
116. The Pelargoniums, 1970, 39, 1.
117. The Red Oleander and the Purple Petrea, 1 39, 25.

2736-71. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Print by V. J. F. Jesudason, L.P.T., Superintendent, at The Bangalore Press, Bangalore-18.

RAMAN SPECTRA OF ACENAPHTHENE AND ACENAPHTHENE-D_{10}

G. D. BARUAH AND SHRI RAM SINGH*

Spectroscopy Department, Banaras Hindu University, Varanasi-5, India

ABSTRACT

The Raman spectra of acenaphthene and acenaphthene-d_{10} have been recorded with the help of a Spex Recording Raman Spectrophotometer using He-Ne Laser source (exciting line 6328 A of Neon). Detailed vibrational assignments of all the sixty fundamental frequencies have been made.

INTRODUCTION

THE vibrational spectrum of acenaphthene has been investigated by several workers in the infrared[1] and in Raman spectra.[2-4] The infrared spectra in polarized light of acenaphthene crystals and molecular vibrations have been investigated by Colombo[5] who assigned 47 fundamental frequencies. The present work deals with the Raman spectra of acenaphthene and its isotopic derivative. Detailed assignments of all the vibrational frequencies have been proposed. The study of the isotopic molecule together with polarization measurement has helped considerably in the vibrational assignment.

EXPERIMENTAL

The chemical acenaphthene was of E-Merck grade. Acenaphthene-d_{10} was obtained from CEA, Department des Radioelements, France. Raman spectra have been recorded with the help of a Spex Recording Raman Spectrophotometer using He-Ne Laser source. The exciting line is 6328 Å of Neon. Spectra have been recorded for two different orientations, normal to each other, of the sample. Figure 1 (*a*) and (*b*) show the Raman spectra of the two molecules.

RESULTS AND DISCUSSION

The crystal spectra of the molecule acenaphthene was investigated by Banerjee[6] and Kitaigorodskii.[7] A refined analysis of the molecule was given by Ehrlich.[8] From these works it has been concluded that the molecule of acenapthene ($C_{12}H_{10}$) belongs to the point group C_{2v}. All the carbon atoms and hydrogen atoms bonded to the aromatic rings lie in the plane of the molecule whereas each of the two CH_2 groups forms a plane normal to the molecular plane.

The sixty fundamentals of acenaphthene molecule are distributed among the four symmetry species $20\,A_1 + 10\,A_2 + 11\,B_1 + 19\,B_2$. The selection rules and vibrational analysis of an isolated molecule are given[5,9] in Table I. The vibrational analysis has been made using the empirical position and intensity rules. The magnitude of the isotopic shift R, the ratio of the frequency of a vibration in the normal molecule to the corresponding frequency in the deuterated molecule has been utilised to measure the correctness of the choice of frequencies in a given species. The values of R associated with different modes of vibrations in benzene and naphthalene are given in Table II. These values have been used as standard ones to identify similar vibrations in acenaphthene and acenaphthene-d_{10}. In interpreting the Raman spectra aid has been taken from the vibrational assignment of the naphthalene molecule.[10-14]

TABLE I

Selection rules and vibrational assignment for acenaphthene

Selection rules			No. of vibrations	
Type	Raman	i.r.	C–C	C–H
A_1	P, $\epsilon_{jk}=0$	M	$6t+5\alpha$	$3s+3\beta+1S+1d+1\triangle$
A_2	D, $\epsilon_{UW}\neq 0$	1	4δ	$3\gamma+1S+1d+1\triangle$
B_1	D $\epsilon_{UV}\neq 0$	M	5δ	$3\gamma+1S+1d+1\triangle$
B_2	D $\epsilon_{VW}\neq 0$	M	$5t+5\alpha$	$3s+3\beta+1S+1d+1\triangle$

s=stretching, α=skeletal in-plane deformation, t=C–C stretching, β=in-plane bending δ=skeletal out of-plane bending, S=C–H stretching in CH_2 group. d=C–H bending in CH_2 group, $\triangle$=twisting and rocking of CH_2 group.

TABLE II

Spectral regions, mode of vibrations and values of R in benzene and naphthalene

Region	Mode of vibration	R
2900–3100	C–H stretching	1·30–1·35
1300–1650	C–C stretching	1·05
900–1050	Ring breathing	..
1000–1500	C–H in-plane bending	1·20–1·28
700–1200	C–H out-of-plane bending	1·20–1·28
1000	Skeletal deformation i.p.	1·05
700	Skeletal deformation o.p.	1·10

---

* Present address : Department of Inorganic and Analytical Chemistry, Hebrew University of Jerusalem, Israel.

VIBRATIONAL ASSIGNMENT

Ten C–H stretching vibrations are expected with distribution as $4 A_1 + 1 A_2 + 1 B_1 + 4 B_2$. We have assigned them as

A_1 (3050, 3030, 2923, 2856)
A_2 (2931)
B_1 (2984)
B_2 (3111, 3079, 2960, 2907)

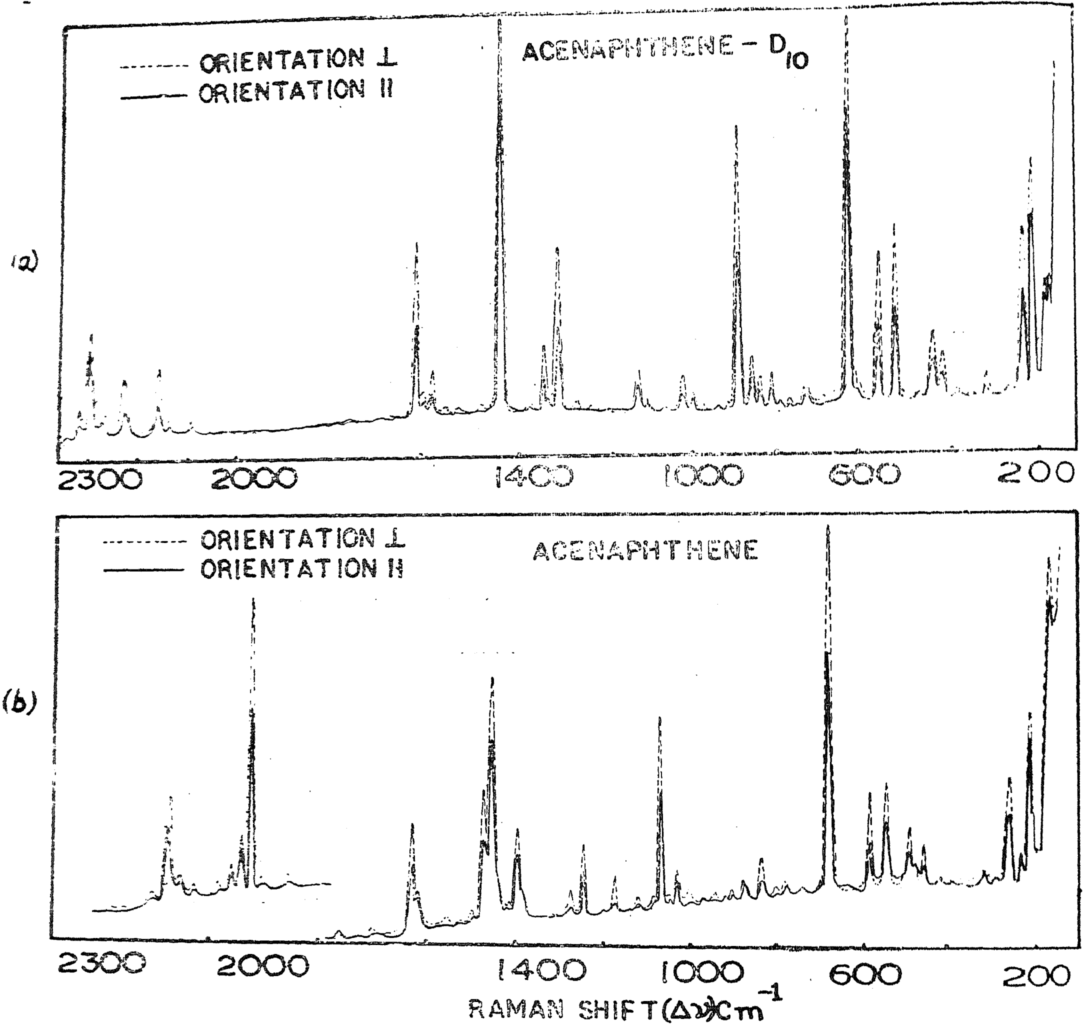


FIG. 1 (*a*–*b*)

The assignment of these modes of vibrations can be compared to the infrared spectrum of the crystal.[5] It is easy to assign the corresponding C–D stretching frequencies in the deuterated molecule from observation of in- and shape of the bands. Table III ational assignment of $C_{12}H_{10}$ and $C_{12}D_{10}$. The values of R have been included in the last column of the table. It may be seen that the values of R observed for the C–H stretching modes of vibrations lie in the region 1·29–1·36, which is in agreement with similar observations in naphthalene. The vibrations characteristic of the CH_2 groups are assigned with the help of the assignments made by Herzberg[15] for C_2H_4O. In C_2H_4O (ethylene oxide) the CH_2 groups lie in a plane normal to the C–O–C ring.

A_1 Species

$(6t + 5\alpha + 3s + 3\beta + 1S + 1d + 1\Delta)$

Four C–H stretching modes are observed as 3054, 3030, 2923 and 2856 cm^{-1}. The band at

TABLE III
Vibrational assignment of acenaphthene and acenaphthene-d_{10}

S.N.	Species	Type	$C_{12}H_{10}$	$C_{12}D_{10}$	R
1	A_1	ν (C–H)	3054	2294	1·33
2		ν (C–H)	3030	2270	1·29
3		ν (C–H)	2923	2159	1·35
4		ν (C–H)	2856	2103	1·36
5		ν (C–C)	1627	1617	1·01
6		ν (C–C)	1617	1597	1·01
7		ν (C–C)	1502	1410	1·06
8		ν (C–C)	1424	1372	1·04
9		ν (C–C)	1393	1309	1·06
10		CH_2 rocking	1278	1107	1·15
11		β (C–H)	1440	1200	1·20
12		β (C–H)	1245	1024	1·22
13		β (C–H)	1176	976	1·20
14		β (C–H)	1122	939	1·19
15		α (C–C–C)	939	902	1·05
16		α (C–C–C)	673	628	1·07
17		α (C–C–C)	572	558	1·02
18		α (C–C–C)	476	437	1·09
19		α (C–C–C)	465	442	1·05
20		ν (C–C)	1054	882	1·19
21	A_2	ν (C–H)	3079	2301(depol)	1·34
22		β (C–H)	1340	1290	1·04
23		CH_2 twisting	1023	..	..
24		γ (C–H)	1042	..	..
25		γ (C–H)	915	..	..
26		γ (C–H)	870	..	..
27		δ (C–C–C)	382	..	..
28		δ (C–C–C)	289	260	1·11
29		δ (C–C–C)	202	..	..
30		δ (C–C–C)	166	153(depol)	1·08
31	B_1	ν (C–H)	2984	2242	1·33
32		γ (C–H)	1440	1152	1·25
33		CH_2 rocking	1382	1270	1·08
34		γ (C–H)	965	764	1·26
35		γ (C–H)	832	731	1·14
36		γ (C–H)	798	724	1·10
37		δ (C–C–C)	776	616	1·25
38		δ (C–C–C)	448	417	1·07
39		δ (C–C–C)	269	250	1·08
40		δ (C–C–C)	233	214	1·09
41		δ (C–C–C)	214	177	1·21
42	B_2	ν (C–H)	3111	2317	1·34
43		ν (C–H)	2931	2187	1·34
44		ν (C–H)	2960	2227	1·33
45		ν (C–H)	2907	2140	1·36
46		ν (C–C)	1780	..	..
47		ν (C–C)	1765	..	..
48		ν (C–C)	1595	..	..
49		ν (C–C)	1496	1390	1·07
50		ν (C–C)	1475	1437	1·03
51		β (C–H)	1455	1340	1·08
52		β (C–H)	1199	998	1·20
53		CH_2 rocking	1150	..	..
54		β (C–H)	1085	917	1·18
55		β (C–H)	899	787	1·14
56		α (C–C–C)	535	516	1·04
57		α (C–C–C)	493	465	1·06
58		α (C–C–C)	413	..	..
59		α (C–C–C)	318	315	1·01
60		α (C–C–C)	262	236	1·11

3054 cm^{-1} corresponds to the frequency 3050 cm^{-1} in the infrared spectrum of the crystal.[5] This was identified as the C–H stretching band in CH_2 group due to an intense Davidov splitting.[5] The frequencies 1278 and 1440 cm^{-1} have been identified as the CH_2 rocking and CH_2 bending corresponding to the frequencies of 1310 and 1416 cm^{-1} in the crystal spectrum.[5] The ring breathing mode of vibration has been assigned to the very strong band at 1054 cm^{-1}. Its isotopic counterpart has been identified as the very strong band at 882 cm^{-1}. The observed ratio of $R = 1{\cdot}19$ is equal to that observed for naphthalene.[14] The ring breathing mode shows a higher value as compared to the corresponding value in the crystal spectrum (1044 cm^{-1}). Other frequencies have been assigned with the help of the data of the crystal spectrum and the isotopic shifts expected.

A_2 Species

$$(4\,\delta + 3\,\gamma + 1\,S + 1\,d + 1\,\Delta)$$

All the ten vibrations of this class are recorded. In the crystal spectrum, only three frequencies were identified. There was a frequency at 1938 cm^{-1} which was attributed as the A_2 type vibration by Colombo.[5] The present Raman spectrum does not show any band with this frequency. The frequency 1340 cm^{-1} has been assigned as the C–H bending mode in CH_2 group corresponding to the frequency 1352 cm^{-1} in the crystal spectrum. In the Raman spectrum of ethylene oxide[15] the CH_2 rocking mode has been assigned to the frequency 1379 cm^{-1}. The C–H stretching frequency in CH_2 group has been identified by Herzberg at 3061 cm^{-1} which is depolarized. In acenaphthene and acenaphthene-d_{10}, the frequencies 3079 and 2301 cm^{-1} are assigned as C–H and C–D stretching modes. These frequencies are also depolarized.

B_1 Species

$$(5\,\delta + 3\,\gamma + 1\,S + 1\,d + 1\,\Delta)$$

Eleven B_1 modes of vibrations could be easily identified. The frequency 2984 cm^{-1} has been assigned as the C–H stretching mode in CH_2 group corresponding to the value 3007 cm^{-1} (polarized) assigned by Herzberg. Other out-of-plane modes are assigned with the help of the comparison made with naphthalene spectrum.

B_2 Species

$$(5\,t + 5\,\alpha + 3\,s + 3\,\beta + 1\,S + 1\,d + 1\,\Delta)$$

The frequencies of this class have also been assigned with the help of a comparison with the crystal spectrum and the naphthalene spectrum. However, all the isotopic counterparts could not be identified.

As regards the degree of depolarization, it has been observed that for totally symmetric vibrations, the values lie between 0 and 6/7. For many vibrations, however, the degree of depolarization could not be precisely determined.

ACKNOWLEDGEMENT

The authors are thankful to Dr. I. S. Singh for helpful discussion. One of them (S. R. S.) is extremely grateful to Prof. Jacob Samir, Head of the Department of Inorganic and Analytical Chemistry, The Hebrew University of Jerusalem, Israel, for the facilities and award of a fellowship to work in his laboratory.

---

1. Richards, R. E. and Thompson, H. W., *Proc. Roy. Soc.* (London), 1941, **195 A**, 1.
2. Manzoni, R., *Atti. Acad. Nazl. Lincei, Rend. Classe. Sci. Fis. Mat. Nat*, 1935, **21**, 166.
3. Luther, H. and Reichel, C., *Z. Physik. Chem.*, 19 **195**, **103.**
4. Mathieu, J. P., Ecollan, M. and Ecollan, J. F., *J. Chem. Phys.*, 1954, **50**, 250.
5. Colombo, L., *Ibid.*, 1963, **39**, 1942
6. Banerjee, K, and Sinha, K., *Indian J. Phys.*, 19 **21**, 21.
7. Kitaigorodskii, A. I., *Zh. Fic. Khim.*, 1949, 23, 1036.
8. Ehrlich, H. W., *Acta Cryst.*, 1957, **10**, 699.
9. Wilson, B. Jr., Decius, J. C. and Cross, P. C., *Molecular Vibrations*, McGraw-Hill Book Company, Inc., New York, 1956.
10. Lippincott, E, R. and O'Reilly, E. J., *J. Chem. Phys.*, 1955, **23**, 238.
11. Person, W. B, Pimental, G. C. and Schnepp, O., *Ibid.*, 1955, **23**, 230.
12. Scully, D. B. and Whiffen, D. H., *Spectrochim. Acta*, 1960, **16**, 1409.
13. — and —, *J. Mol. Spectry.*, 1957, **1**, 257.
14. Bree, A. and Kydd, R. A., *Spectrochim. Acta*, 19 **26 A**, **1791.**
15. Herzberg, G., *Molecular Spectra and Molecular Structure*, D. Van Nostrand, Inc., Princeton, New Jersey, 1959, p. 341.

A NOTE ON THE OCCURRENCE OF BENSTONITE, A CARBONATE OF CALCIUM AND BARIUM FROM THE CARBONATITE COMPLEX AT JOGIPATTI, NEAR SAMALPATTI, DHARMAPURI DISTRICT, TAMIL NADU

E. I. SEMENOV, V. GOPAL AND V. SUBRAMANIAN

Tamil Nadu Mineral Development Project (United Nations Development Programme), Madras-32, Tamil Nadu, India

ABSTRACT

Benstonite, a carbonate of calcium and barium has so far been reported from two other localities in the world, *viz.*, from Argansas, U.S.A. (Lippman, 1962) and Längbam, Sweden (Sandius, 1963). This paper deals briefly with the mineralogy and petrogenesis of a new occurrence from Jogipatti, India. Benstonite at Jogipatti is related to the carbonatites in which it occurs in a massive form. From the field data it is concluded that the formation of benstonite took place at high temperature, although it is generally postulated that the introduction of barium is an indication of late low temperature activity. However in the area under consideration, benstonite is associated with coarse black pyroxene and white feldspar which are usually high temperature minerals.

IN 1968, during the course of a detailed field examination of the carbonatite occurrences near Koratti, the authors recognised several other satellite bodies of carbonatites out of which the occurrence near Jogipatti drew special attention in that they came across a massive light yellow carbonate which looked rather different from the other carbonate minerals usually associated with carbonatites. This mineral has subsequently been identified as benstonite.

Jogipatti is a small village situated about 1·5 kilometres north of Samalpatti R.S. lying on the Tirupathur-Salem Broad Gauge Section of the Southern Railway. It falls in Uttangarai Taluk of Dharmapuri District in the State of Tamil Nadu (*Survey of India Toposheet* 57 L/7).

The principal rocks encountered in the area are syenites in which occur carbonatites, pyroxene pegmatites and veins of quartz barytes. The syenites are mostly made up of alkali feldspar with a few ferromagnesium and other accessory minerals. The carbonatites occur as small lenses within the syenites. About seven such bodies were noticed in the field. The dimension of the individual bodies varies widely. They are generally elongated in a N 70° E to E direction. The carbonatites are generally made up of calcite, dolomite, and well-developed crystals of magnetite and apatite. In one of the bodies near Jogipatti village, large quantities of benstonite were noticed. This carbonatite lens is about 50 metres long and 3 to 5 metres wide. In association with this carbonatite, a coarse-grained pyroxene-pegmatite is noticed, in which also occurs benstonite.

The occurrence of benstonite in the carbonatite is generally in the massive form. In the pyroxene pegmatites, the benstonite occurs associated with coarse aegerine and big, white tabular crystals of the potash feldspar, orthoclase. Along the core of these pegmatites both benstonite and monazite are developed.

Mineralogy.—The mineral, benstonite, has a distinctive rhombohedral cleavage. It has a hardness of 3 and a specific gravity of 3·41. It is uniaxial, negative, but at times has a very low optical axial angle. It develops complex twinning. In its physical and optical properties, benstonite from Jogipatti closely resembles the type mineral from Arkansas as may be seen from the comparative table (Table I).

TABLE I

Physical and optical properties of benstonite

	Jogipatti	Arkansas
a_0	18·32	18·38
C_0	8·66	8·67
G	3·41	3·59
N_o	1·69	1·690
N_e	1·53	1·527

Calculated by G A. Sidorenko.

The optical and thermal properties (DTA, TG and DTG) are similar to those of other Ba-Ca carbonates like alstonite and baryto-calcite.

The differential thermal analysis and thermogravimetric analyses (TG and DTG) curves are shown in Fig. 1. From the thermogravimetric curves the first endothermal peak at 850° C (without any loss in weight) may be taken as corresponding to the decay of $CaCO_3$ and $BaCO_3$. The second endothermal peak at 900° C is characteristic of $CaCO_3$ dissociation (loss in weight : 21% of total CO_2). Small thermo effects occur near 830° C and 1050° C.

The infrared spectrum of benstonite (shown in Fig. 2) is very characteristic and is quite different from the infrared curves of either alstonite or baryto-calcite.

The chemical analysis of the Jogipatti occurrence is shown in Table II and leads to the formula $Ca_{1.8}$ $Sr_{0.2}$ $Ba_{0.9}$ $Ce_{0.1}$ $(CO_3)_3$ or approximately to Ca_2Ba $(CO_3)_3$. The postulated formula of Lippman (1962) as $Ba_6Ca_7(CO_3)_3$ is too complex and is perhaps based on the analysis of admixed material (admixture of baryte, etc.). Even though strontium can isomorphically replace calcium, barium replacement of calcium is considered to

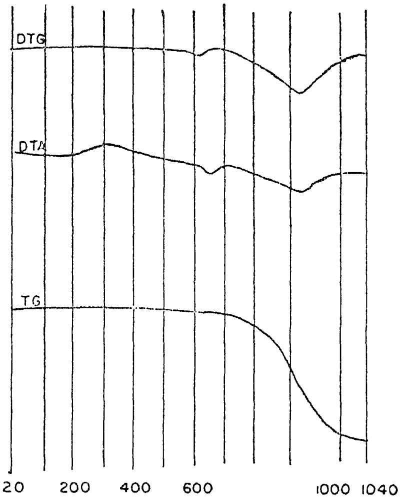


PLATE – I

THERMOCURVE OF BENSTONITE

FIG. 1

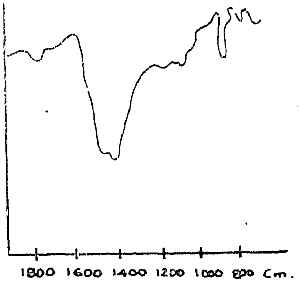


PLATE – 2

INFRARED CURVE OF BENSTONITE

FIG 2

be more probable. Rare earths (1·8%) occurs both in the soluble and insoluble portions. The presence of rare earths in the insoluble portions may be taken as due to admixture with monazite. From the X-ray spectral analysis it has been determined that the soluble rare earths are essentially cerian: La 27·5, Ce 48·3, Pz 4·7, Nd 18·8, Sm 2·7, Eu 0·3 and Gd 0·5.

TABLE II

Chemical analysis of benstonite from Jogipatti, India

Constituents	Jogipatti	Arkansas
BaO	32·68	43·05
SrO	4·50	4·02
CaO	24·18	19·52
MgO	..	1·69
MnO	0·10	0·35
Fe_2O_3	0·34	..
TR_2O_3 (rare earths)	1·77	..
P_2O_5	0·29	..
CO_2	33·52	31·35
Na_2O	0·33	..
K_2O	0·01	..
Non-soluble	1·03	..
Total	98·75	99·98
Analyst	Z. Kataeva	F. Lippman

At Jogipatti, the origin of benstonite is closely related to the carbonatites. Carbonatites usually have a genetic connection with pyroxenites and urtites. However, only syenites and pyroxenites are present in the above area. These rocks are generally rich in barium. In the carbonatites, only benstonite is responsible for the enrichment of barium, whereas in the syenites, their pegmatites and hydrothermalites, only barite and barium feldspar, have been noticed so far.

The barium enrichment in the carbonatite complexes have usually been considered as the last low temperature phase of hydrothermal activity. But here in Jogipatti, barium is introduced in the carbonatites as benstonite with which are associated coarse crystals of black pyroxene and feldspar which are usually products of high temperature formations. Hence, it is concluded that the benstonite should also have a high temperature mode of occurrence.

The mineralogical determinations were made in the Institute of Mineralogy, Geochemistry and Crystal Chemistry of Rare Elements in Moscow as part of the investigations on samples sent from the Tamil Nadu Mineral Development Project under the United Nations Development Programme.

1. Lippman, F., "Benstonite $Ca_7Ba_6(CO_3)_{13}$ a new mineral from barite deposit, Hot Spring County, Arkansas, U.S.A.," *American Mineralogist*, 1962, **47.**
2. Sandius, N., "Benstonite and Tephrite from Langbam," *Arkiv. Mineralegical Geol.*, Stockholm, 1963, **3.**

FLOW BETWEEN ECCENTRIC SPHERES

N. RUDRAIAH AND C. JANAKAMMA

Department of Mathematics (Post-Graduate Studies), Visvesvaraya College of Engineering, Bangalore University, Bangalore

THE flow of a viscous incompressible fluid between two eccentric cylinders has been investigated by Rudraiah and Geetha (1969) whose results are of interest in the liquid bearing systems. The flow of a viscous incompressible fluid between eccentric spheres is not only of interest in the lubrication theory but also is of interest in the geophysical problems, particularly in the discussion of fluid in the earth core. This problem has not been given much attention earlier and it is discussed in this paper. The main difference between Rudraiah and Geetha problem and our problem is that in their problem the bearing system has a line contact, whereas in our problem the bearing system has a point contact. As a consequence of this point contact we get side leakage of liquid about the point of contact which develops the adverse pressure gradient. The physical reason for this is as follows. When one of the spheres gets displaced to an eccentric position, new effects appear. First, a pressure gradient is created which tends to restore concentricity and it may cause the back flow. A second, an eddy adjacent to the outer sphere, is created in the region of largest clearance. To study these effects, the steady flow of a viscous incompressible fluid between two eccentric spheres, when the inner sphere of radius R_1 is rotating while the outer sphere of radius R_2 is stationary is investigated under the narrow gap approximation. The flow in the axial direction is assumed to be small compared with the flow in the radial and azimuthal directions.

Let (α, β, γ) be the spherical bipolar co-ordinates. The transformation from the cartesian co-ordinates (x, y, z) to the spherical bipolar system (α, β, γ) is given by

$$x = \frac{a \sinh \alpha}{\cosh \alpha - \cos \beta}, \quad y = \frac{a \sin \beta \cos \gamma}{\cosh \alpha - \cos \beta},$$

$$z = \frac{a \sin \beta \sin \gamma}{\cosh \alpha - \cos \beta} \tag{1}$$

and the corresponding Lames constants (h_1, h_2, h_3) are given by

$$h_1 = h_2 = \frac{a}{\cosh \alpha - \cos \beta},$$

$$h_3 = \frac{a \sin \beta}{\cosh \alpha - \cos \beta}. \tag{2}$$

If ψ and ϵ are respectively the clearance and eccentricity ratios, it can be shown, since

$$R_1 = -\frac{a}{\sinh \alpha_1}, \quad R_2 = -\frac{a}{\sinh \alpha_2}$$

that

$$\psi = \frac{R_2 - R_1}{R_2} = \frac{C}{R_2} = \frac{\sinh \alpha_1 - \sinh \alpha_2}{\sinh \alpha_1} \tag{3}$$

$$\epsilon = \frac{\sinh (\alpha_1 - \alpha_2)}{\sinh \alpha_1 - \sinh \alpha_2}. \tag{4}$$

The required equations, under the above approximations, following the analysis of Rudraiah and Geetha (1969) and using the basic equations derived by Rudraiah and Janakamma (1970), are

$$\frac{\partial p}{\partial \zeta} = 0 \tag{5}$$

$$\frac{\partial^2 v}{\partial \zeta^2} + H\psi(1-\epsilon^2)^{\frac{1}{2}} \frac{\partial v}{\partial \zeta} = RH\psi (1 - \epsilon^2) \frac{\partial p}{\partial \beta} \tag{6}$$

$$H^2 \sin \beta \frac{\partial u}{\zeta \partial} + \frac{\partial}{\partial \beta} (H^2 v) = 0 \tag{7}$$

where u and v are dimensionless velocity components in α and β directions respectively, p is the pressure,

$$\zeta = \frac{\alpha - \alpha_1}{t}, \quad t = \psi (1 - \epsilon^2)^{\frac{1}{2}}.$$

$$H = \frac{(1 - \epsilon^2)^{\frac{1}{2}}}{1 - \epsilon \cos \beta}, \quad R = \frac{V_0 C}{\nu}$$

and V_0 is the rotation of the inner sphere. The boundary conditions are

$$u = 0 \quad \text{at} \quad \zeta = 0, 1 \tag{8}$$

$$v = 1 \quad \text{at} \quad \zeta = 0, \tag{9}$$

$$v = 0 \quad \text{at} \quad \zeta = 1 \tag{10}$$

and u, v, p are periodic in β. The solutions of (5) to (7) using the boundary conditions (8) to (10) are:

$$u = K_1 \left(\frac{\zeta^2}{2} - \frac{\zeta^3}{3}\right) + K_2 \left(K_3 \zeta^2 - \frac{K_4}{3} \zeta^3\right) + K_5 \left(\frac{\zeta^2}{2} - \zeta\right) \left\{(1 - \epsilon \cos \beta) \left(2 - \frac{\psi (1 - \epsilon^2)}{2a_4}\right)\right\}$$

$$+ K_5 \left(\zeta - \frac{\zeta^3}{3}\right) \left(\frac{3}{2} \psi (1 - \epsilon^2) - \frac{\psi^2 (1 - \epsilon^2)^2}{4a_4}\right) \tag{11}$$

$$v = K_6 (\zeta - \zeta^2) + \frac{1}{a_4} \left\{\zeta (1 - \epsilon \cos \beta) - \frac{\psi (1 - \epsilon^2)}{2} \zeta^2 + a_4\right\} \tag{12}$$

$$p - p_0 = \frac{1}{R\psi (1 - \epsilon^2)^{3/2}} [a_1 \epsilon \sin \beta + a_2 \epsilon^2 \sin 2\beta + a_3 \epsilon^3 \sin^3 \beta] \tag{13}$$

where p_0 is the static pressure.

$$a_1 = \left\{\frac{4 (1 - 2K + \epsilon^2) (1 + 4K)}{[2K + \epsilon^2 (K - 2)]} - 6\right\};$$

$$a_2 = \left\{\frac{(K - 2) (1 + 4K)}{[2K + \epsilon^2 (K - 2)]}\right\},$$

$$a_3 = \left\{-\frac{4}{3} \frac{(1 + 4K}{[2K + \epsilon^2 (K-2)]}\right\},$$

$$a_4 = (K + \epsilon \cos \beta),$$

$$2K = [\psi (1 - \epsilon^2) - 2],$$

$$K_1 = \left\{\frac{a_1 \epsilon + 8a_2 \epsilon^2 \cos \beta - \epsilon^3 (\cos^2 \beta + \cos 2\beta)}{2a_4}\right\},$$

$$K_2 = \frac{\epsilon}{1-\epsilon\cos\beta}\left\{a_1\epsilon\cos\beta + 2a_2\epsilon^2\cos 2\beta + \frac{3}{2}\sin\beta\sin 2\beta\right\},$$

$$K_3 = \left\{\frac{1}{\psi(1-\epsilon^2)} + \frac{2(1-\epsilon\cos\beta)}{a_4\psi(1-\epsilon^2)} - \frac{1-\epsilon\cos\beta}{2a_4^2}\right\},$$

$$K_4 = \left\{\frac{4a_4 - 2(1-\epsilon\cos\beta)}{4a_4^2}\right\},$$

$$K_5 = \frac{\epsilon}{a_4(1-\epsilon\cos\beta)},$$

$$K_6 = \left\{\frac{2a_1\epsilon\cos\beta + 4a_2\epsilon^2\cos 2\beta + 3\epsilon^3\sin\beta\sin 2\beta}{4a_4}\right\}.$$

The shearing stress τ is defined by the equation

$$\tau = \frac{\mu V_0}{a}\left[\frac{\partial}{\partial\alpha}(v\cosh\alpha - v\cos\beta) + t\frac{\partial}{\partial\beta}(u\cosh\alpha - u\cos\beta)\right]$$

The expression for skin-friction coefficient

$$c_f = \frac{\tau}{\frac{\mu V_0}{a}}$$

is

$$c_f = \frac{\partial}{\partial\alpha}(v\cosh\alpha - v\cos\beta) + t\frac{\partial}{\partial\beta}(u\cosh\alpha - u\cos\beta).$$

From equation (14), using equations (11) and (12), we can obtain skin friction coefficient at the inner and outer spheres.

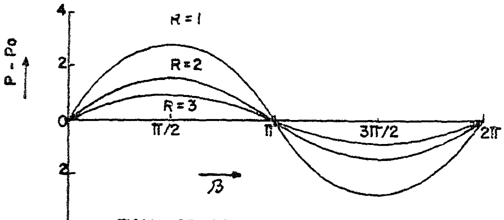


FIG: I PRESSURE DISTRIBUTION

The velocity and pressure distributions are plotted in Figs. 1 and 2. The velocity distribution shows that the velocity components in the radial and axial directions are much smaller than the azimuthal direction and the azimuthal velocity distribution exhibits the back flow for $\beta = 0$ and $\beta = \pi/4$. The reason for this back flow is mainly because of the adverse pressure gradient set up by the point leakage in the spherical bearing system. We find that the pressure decreases with increasing Reynolds number as shown in Fig. 2.

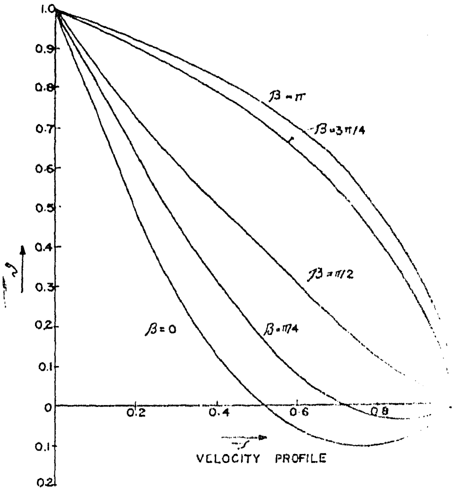


FIG. 2

ACKNOWLEDGEMENT

One of us (C. J.) is grateful to U.G. awarding a Junior Research Fellowship.

---

1 Rudraiah, N. and Geetha, *Cur. Sci.*, 1969, 134.

2. Ritchie, G. S., *J. Fluid Mech.*, 1968, **32,** 131.

3. Rudraiah, N. and Janakamma, C., *PGSAM.*, 2

CRINKLED LEAF MUTATION—A CASE OF INCOMPLETE GENE PENETRANCE IN *NICOTIANA TABACUM* L.*

R. LAKSHMINARAYANA, D. M. GOPINATH AND K. V. KRISHNAMURTHY
Central Tobacco Research Institute, Rajahmundry

ABSTRACT

A spontaneous mutant with crinkled leaf surface was spotted among the population of an advanced breeding line H.R. 65-29 in flue-cured tobacco. As all tests—cytological and genetical—did not give clue as to the definite nature of the gene and based on the differential segregating pattern of the mutant into normal and mutant like plants in the subsequently selfed and crossed progenies, it is inferred that the mutation is an outcome of an incomplete gene penetrance. Tentatively the basic gene is assigned the symbol *Crl.*

DESCRIPTION OF THE MUTANT

THE advanced breeding line H.R. 65-29, in which the mutation occurred was a derivative from a cross involving two flue-cured tobacco varieties Chatham and Delcrest. The leaf of the mutant had thoroughly changed from those of the parents. Besides the surface of the leaf forming heavy crinkling, the shape of the leaf also got transformed from lanceolate elliptic to nearly round (Fig. 1). Flowering was, however, normal and profuse and good pollen and seeds were formed on these plants. Cytologically, no abnormality was noticed in the meiotic stages. However, when selfed seeds of the mutant were sown, both normal-like and mutant-like plants (N.L.P. and M.L.P.) appeared in different numbers. This phenomenon was carefully followed up by genetic tests.

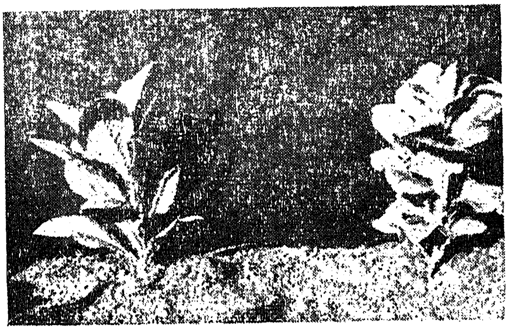


FIG. 1. H.R. 65·29 Normal (Left) and Mutant (Right) plants.

GENETIC TESTS

The mutant was crossed to the normal plant of H.R. 65-29 in which it was observed and also to Chatham and Delcrest, the original parents involved in the breeding line. Reciprocal crosses were also made. Scoring of the plants into N.L.P. and M.L.P. was done in the mutant selfed, F_1, F_2 and BC_1 progenies (Tables I, II and III).

As could be seen from the tables, the segregation of N.L.P. and M.L.P. indicate that the mutation is neither recessive nor dominant and that it does not follow any genetic pattern. Taking into consideration the peculiar behaviour of the mutant plant which did not show any fit either for Mendelian or non-Mendelian ratios on the one hand and following the normal course of meiosis, normal pollen fertility and seed setting on the other hand, it is plausible to interpret that the underlying genetic mechanism of this material may be incomplete gene penetrance and expressivity. Wolf and Gerstel (1966) observed that the fasciation in oriental tobacco might be due to the genetic phenomenon of penetrance. In a similar situation, Wolf (1962) interpreted that bifurcate branching of tobacco follows penetrance.

In the present investigation, the magnitude of penetrance of the gene for crinkled leaf was calculated in the different progenies and has been estimated to be in the range of 0·27 to 48·88% (Table III). While scoring the plants

TABLE I

Penetrane per cent of the mutation in parents and F_1s

S. No	Progeny	N.L.P.	M L.P.	Total	Penetrance %
1	H.R. 65-29 Mutant-selfed (1966-67)	100	14	114	12·28
2	H.R. 65-29 Mutant selfed (1967-68)	381	210	591	35·53
3	H.R 65-29 N.L.P. (selfed) and F_1s	All	..	..	..
4	H.R. 65-29 Normal plant × H.R 65-29 Mutant	54	19	73	26·03
5	H.R. 65-29 Mutant × Delcrest	56	4	60	6·67
6	Delcrest × H.R. 65-29 Mutant	89	5	94	5·32
7	H.R. 65-29 Mutant × Chatham	29	3	32	9·38
8	Chatham × H.R. 65-29 Mutant	46	22	68	32·35

N L.P. = Normal-like plant, M.L.P. = Mutant-like plant

---

* Paper presented at the 58th session of the Indian Science Congress held at Bangalore, 1971

TABLE II

Penetrance per cent of the mutation in F_2s

S. No.	Progeny	N.L.P.	M.L.P.	Total	[illegible]
1	H.R. 65-29 Normal × H.R.65-29 Mutant—N.L.P.	All	..	..	..
2	,, —M.L.P.	638	246	884	[illegible]
3	H.R. 65-29 Mutant × Delcrest—N.L.P.	49	7	56	[illegible]
4	,, —M.L.P.	1520	424	1944	[illegible]
5	Delcrest × H.R. 65-29 Mutant—N.L.P.	1250	13	1263	[illegible]
6	,, —M.L.P.	1570	26	1596	[illegible]
7	H.R. 65-29 Mutant × Chatham—N.L.P.	950	4	954	[illegible]
8	,, —M.L.P.	719	470	1189	[illegible]
9	Chatham × H.R. 65-29 Mutant—N.L.P.	All	..	..	..
10	,, —M.L.P.	1473	628	2101	[illegible]

N.L.P. = Normal-like plant, M.L.P. = Mutant-like plant.

TABLE III

Penetrance per cent of the mutation in BC'_1s

S. No.	Progeny	N.L.P.	M.L.P.	Total	[illegible]
1	(H.R. 65-29 Normal × H.R. 65-29 Mutant-M.L.P.) H.R. 65-29 Mutant)	397	200	597	[illegible]
2	(,,) H.R. 65-29 Normal)	322	9	331	[illegible]
3	(,, N.L.P.) H.R. 65-29 Mutant)	287	48	335	[illegible]
4	(,, H.R. 65-29 Normal)	367	1	368	[illegible]
5	(H.R. 65-29 Mutant × Delcrest—M.L.P.) H.R. 65-29 Mutant	360	53	413	[illegible]
6	(,,) Delcrest	407	54	461	[illegible]
7	(,, —N.L.P.) H.R.65-29 Mutant	85	20	105	[illegible]
8	(,,) Delcrest	All	..	..	..
9	(Delcrest × H.R. 65-29 Mutant—M.L.P.) Delcrest	327	3	330	[illegible]
10	(,, —N.L.P.) Delcrest	All	..	..	..
11	(,, —N.L.P.) H.R. 65-29 Mutant	153	21	174	[illegible]
12	(Chatham × H.R. 65-29 Mutant—M.L.P.) H.R. 65-29 Mutant	221	70	291	[illegible]
13	(H.R. 65-29 Mutant × Chatham—M.L.P.) H.R. 65-29 Mutant	160	153	313	[illegible]
14	(,, —N.L.P.) H.R. 65-29 Mutant	114	14	128	[illegible]

N.L.P. = Normal-like plant, M.L.P. = Mutant like plant.

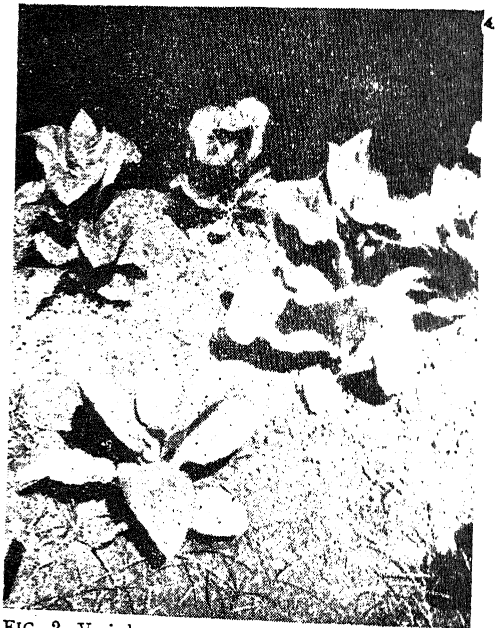


FIG. 2. Varied expressivity of the crinkling leaf character in different plants. Foreground-normal plant.

into N.L.P. and M.L.P. an interesting feature observed was that the intensity of the expression of the crinkled nature of the [illegible] (Fig. 2). Hence, it is inferred that [illegible] tion here is a case of incomplete [illegible] with a variable expressivity and the [illegible] is symbolised as *Crl*. This may be [illegible] ral reasons like the nature of gene [illegible] the action of the gene during [illegible] might be weak and it can easily be [illegible] by the composite action of other gen[illegible] by environmental conditions (Rile[illegible] Here all the progenies were examined [illegible] similar environmental conditions. [illegible] trance of the gene might be due to [illegible] of modifying genes (Hutt and Chil[illegible] That modifiers play an important [illegible] tobacco genetics is well known. The [illegible] trance effect in the present mutation [illegible] due to their interaction

---

*1 Hutt, F. B. and Child, G. P., *J. [illegible]* 25, 341.

2. Riley, H. P., *Introduction to Genetics and [illegible]* Chapter 3. John Wiley & Sons, Inc., N[illegible] 1949, pp 32.

3. Wolf, F. A., *Tobacco Sci.*, 1962, 6, 188.

4. — and Gerstel, D. U., *Ibid.*, 1966, 10, 12.

*Original not seen.

LETTERS TO THE EDITOR

CAPACITANCE AND THICKNESS OF SPACECHARGE SHEATHS AT PLASMA-WALL BOUNDARY

ABSTRACT

Dynamic response of the spacecharge sheath at plasma-wall boundary is theoretically discussed considering the non-uniform electric field in the sheath and its effective non-linear resistance. A pulse method for obtaining the equivalent sheath capacitance and resistance has been suggested.

THE spacecharge sheath at a plasma-wall boundary represents a transition region which arises from and is supported by the plasma which it circumscribes. It is essentially a non-plasma region which sustains the charge unbalance with consequent local electric fields as a result of the random bipolar charge-carrier currents derived from the plasma which flow through it. The presence of the sheath most often distorts and sets a limit to the diagnostic information pertaining to the plasma to be obtained by observation. It is usual[1] to evaluate the disturbance produced by the sheath by assuming it to be equivalent to an effective capacitance in parallel with an effective resistance. An analogous situation is encountered, it will be recalled, in the case of semiconductors junctions[2,3] where one can estimate the thickness of the spacecharge region by measuring the equivalent capacity by observations of its r.f. impedance. It has not been possible to carry out similar measurement for the sheath region at the plasma-wall (foreign surface) boundary. The problem has been recently[1] theoretically discussed for the sheath region formed in front of a single thin wire Langmuir probe immersed in a low temperature plasma. One of the difficulties in interpreting the results of the measurements is the significantly non-linear character of the equivalent resistance. One can assume a typical Langmuir volt-ampere characteristic for the probe and specify the conditions where it can be simply estimated. A determination of the effective capacitance of the sheath around wire probes even under such well-defined conditions becomes difficult because of the attendant stray capacitances due to associated structures and circuit layout[4] which are not negligible in comparison with the capacitance to be measured.

We have, therefore, examined the problem by considering the sheath capacitance formed in front of a large area cylindrical probe placed near the wall of a cylindrical gas discharge tube. It is clear that the use of a large area for the probe will significantly affect its characteristic since it may partly function also as one of the electrodes. One can limit the net current received by such a probe by inserting a suitably high serial resistance. A knowledge of its d.c. characteristic will provide an estimate for the incremental equivalent resistance. Then the probe functions as a single Langmuir probe[5] operated at a potential other than the floating value, the current I_{cp} received by it can be expressed as

$$I_{cp} = a_0 - a_1 e^{-eV/kT_e} \tag{1}$$

where a_0 represents (1) the positive ion current which can be assumed to be approximately equal to random positive ion current incident on the plasma-sheath boundary; (2) a part of the total drift current which flows through the plasma as the probe may also function partly as an auxiliary electrode. The second term represents the contribution of the electron current which alone is generally assumed to be sensitive to the d.c. probe potential. One can, therefore, define an incremental non-linear resistance for the sheath in front of the probe

$$R_p = \frac{dV}{dI_{cp}} = \frac{kT_e}{ea_1} e^{-eV/kT_e}. \tag{2}$$

At this stage attention may be drawn to another special characteristic of the problem which has not been thus far considered. The geometrical dimensions of the sheath region are usually calculated by assuming the simple electrostatic expression for the capacity of a parallel plate condenser, the derivation of which involves the assumption of a uniform electric field. As the sheath region is characterised by significant spacecharge effects, a modification of this expression is necessary. For this purpose one makes use of the result that the electric field (E) in this region is given by

$$|E| = \frac{V_s}{\lambda} e^{-x/\lambda} \tag{3}$$

with the boundary conditions that at the wall $x = 0$, $V = -V_s$ and at the plasma-end of the sheath $x = \lambda$, $V = 0$. Using Poisson's equation for one dimension (spacecharge volume density ρ and sheath area A assumed to be constant)

$$4\pi\rho = \frac{dE}{dx} \approx \frac{V_s}{\lambda^2} e^{-x/\lambda}. \tag{4}$$

Therefore, total charge Q in the sheath region is given by

$$Q = A\int_0^\lambda \rho\, dx = \frac{AV_s}{4\pi\lambda}\left[1 - \frac{1}{e}\right]. \tag{5}$$

The capacity C_1 is given by

$$\frac{\partial Q}{\partial V}$$

therefore

$$C_1 = \frac{A}{4\pi\lambda}\left[1 - \frac{1}{e}\right] = \frac{0{\cdot}63A}{4\pi\lambda} \tag{6}$$

which shows that the capacity gets reduced by the factor 0·63 on account of the spacecharge.

The dynamic behaviour of the sheath can be described in terms of the equivalent circuit (C_1, R_p) shown in Fig. 1 where R′ is a known resistance which enables the waveform of the current to be studied with a C.R.O. Instead of finding the response of the sheath to the steady sinusoidal r.f. signal usually employed, which, however, may alter the steady-state condition of the plasma, it is advisable to use a unit step-function $H(t)$ probing voltage signal. The equations under these conditions are

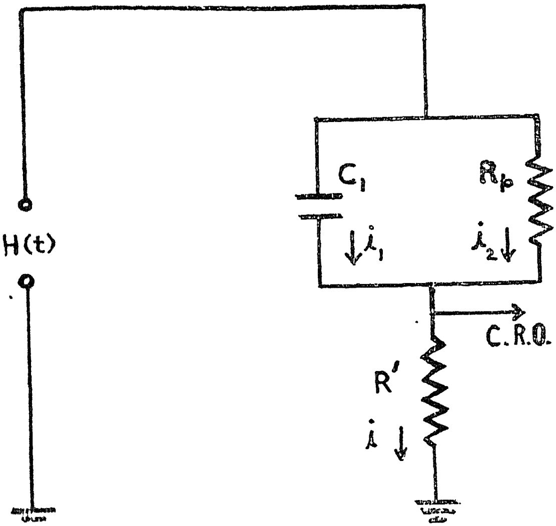


FIG. 1

$$\left.\begin{aligned} \frac{q_1}{C_1} + R'i &= H(t) \\ i &= i_1 + i_2 \\ \frac{Q_1}{C_1} &= i_2 R_p \end{aligned}\right\} \tag{7}$$

which yield using the method of Laplace transforms

$$R'i = \frac{R_p}{R_p + R'} + \frac{R_p^2}{R'(R_p + R')} e^{-\frac{R_p + R'}{C_1 R' R_p} t}. \tag{8}$$

The time constant involved is

$$\tau = \frac{C_1 R' R_p}{R_p + R'}.$$

One can find the magnitudes of C_1 and R_p by determining τ for two different values of R′. This value of C_1 enables calculation of sheath thickness λ from Equation (6).

The pulse method for obtaining sheath capacitance and thickness has the additional advantage of giving information on the frequency response of the sheath impedance and consequently in defining the properties of the plasma being sampled over a wide frequency range.

Ion Physics and Electronics Lab.,
Dept. of Physics,
Institute of Science,
Bombay-32, *March* 22, 1971.

V. T. CHIPLONKAR.
Y. R. DESAI.*

---

* Senior Research Fellow, Department of Atomic Energy, Government of India.

1. Basu, J. and Sen, C., *Proc. IEEE*, 1967, **55**, 1767.
2. Wang, S., *Solid State Electronics*, McGraw-Hill, Kogakusha, 1966, p. 316.
3. Gibbons, J. F., *Semiconductor Electronics*, McGraw-Hill, Kogakusha, 1966, p. 174.
4. Sprott, J. C., *Rev. Sci. Instr.*, 1966, **37**, 897.
5. Chen, F. F., In *Plasma Diagnostic Techniques*, R. H. Huddlestone and S. L. Leonard, eds., Academic Press, New York, 1965.

AN X-RAY CRYSTALLOGRAPHIC STUDY OF ANTIPYRINE, AMIDOPYRINE, PHENYLBUTAZONE AND SALIPYRINE

DERIVATIVES of salicylic acid, pyrazole and acetanilide are extensively used as pain-relieving medicines. A large body of chemical and biological data on the medicinal role of these non-narcotic analgesics, when administered individually and in combinations, are presently available. However, the molecular basis of their interactions among themselves and with biological macromolecules are not yet clearly understood. Therefore, a programme of systematic X-ray, spectroscopic and theoretical investigations of these drug molecules, and their complexes among themselves and with other biologically important molecules has been initiated. As part of this programme, the results of a preliminary crystallographic study of the three best known pyrazole derivatives, *viz.*, antipyrine, amidopyrine and phenylbutazone and a 1 : 1 molecular complex of one of them (antipyrine) with salicylic acid are reported here.

Large, transparent, plate-like crystals of antipyrine and amidopyrine were grown by slow evaporation at room temperature of their solutions in water and 95% alcohol respectively. Controlled evaporation of an alcoholic solution of phenylbutazone gave thin needle-like crystals. Attempts to grow larger crystals by changing the solvent and also by using vapour and solute diffusion techniques were not successful. Transparent platy crystals of the 1 : 1 complex between salicylic acid and antipyrine (generally known as salipyrine) were grown by slowly evaporating a solution in alcohol of the components in molar ratio. The composition of the crystals was confirmed by an examination of the ultraviolet absorption spectra of the two components and the complex in 50% alcohol.

TABLE II

Crystal data for antipyrine, amidopyrine, phenylbutazone and salipyrine

	Antipyrine*	Amidopyrine	Phenylbutazone	Salipyrine
Space group ..	*Cc* or C2/*c*	P1 or P$\bar{1}$	P2_1/*c*	P2_1/*c*
a in Å ..	16·919±0·003	7·55 ±0·02	21·695±0·004	12·77±0·03
b in Å ..	7·425±0·003	10·73 ±0·03	5·823±0·002	7·46±0·02
c in Å ..	17·796±0·003	17·72 ±0·04	27·881±0·004	17·93±0·03
α in degrees ..	..	94·00 ±0·50	..	..
β in degrees ..	117·03 ±0·10	100·78 ±0·50	108·06±0·10	90·00±0·50
γ in degrees ..	..	106·95 ±0·50	..	..
Volume of the unit cell in Å^3 ..	1991·247	1338·483	3348·565	1708·087
Molecular formula ..	$C_{11}H_{12}ON_2$	$C_{13}H_{17}ON_3$	$C_{19}H_{19}O_2N_2$	$C_{11}H_{12}ON_2.C_7H_6O_3$
Formula weight ..	188·112	231·30	307·168	326·35
No. of formula wts. in the unit cell	8	4	8	4
Measured density in gm/cc ..	1·259±0·020	1·176±0·20	1·211±0·020	1·300±0·020
Calculated density in gm/cc ..	1·255	1·148	1·218	1·269

* The crystal data for antipyrine has earlier been reported,[2] though the cell diamensions were somewhat in error. However, the values determined now are reported for the sake of completeness.

The unit cell dimensions of the crystals were determined from oscillation and Weissenberg photographs taken about crystallographic axes using nickel-filtered copper radiation. The cell dimensions of the crystals of antipyrine and phenylbutazone were later refined on a computer-controlled Hilger and Watts 4-circle diffractometer. From systematic absences, the crystals of phenylbutazone and salipyrine could be uniquely assigned to the space group P2_1/*c*. The crystals of amidopyrine belong to the space group P1 or P$\bar{1}$ and those of antipyrine, to the space group Cc or C2/*c*. In the case of antipyrine, the statistical distribution of E values[1] (Table I), computed from the intensity data collected on a 4-circle diffractometer, suggested the space group to be centrosymmetric and hence C2/*c*. The densities of the samples were measured by flotation method using a mixture of benzene and carbon tetrachloride for antipyrine and salipyrine, and a solution of potassium iodide for amidopyrine and phenylbutazone. These data are listed in Table II.

TABLE I

Distributiin of |E|'s for the crystals of antipyrine. Theoretical values are also given for comparison

	Observed values	Theoretical values	
		Centro-symmetric	Non-centro-symmetric
$<\|E\|^2>$ ..	1·040	1·000	1·000
$<\|\|E\|^2-1\|>$ ..	1·005	0·968	0·736
$<\|E\|>$ ..	0·814	0·798	0·886
$\|E\|>1$, % ..	30·2	32·0	36·8
$\|E\|>2$, % ..	4·7	5·0	1·8
$\|E\|>3$, % ..	0·8	0·3	0·01

The complete structure determination of these compounds is in progress.

The author is grateful to Drs. Dan Mercola and Kalyani Vijayan for much help and many discussions. His thanks are also due to Messrs. Geigy (U.K.) Ltd. for a free gift of the sample of phenylbutazone used in these investigations.

Chemical Crystallography Lab., M. VIJAYAN.
Oxford University, Oxford;
and
Dept. of Physics,
Indian Institute of Science,
Bangalore-12, *April* 20, 1971.

---

1. Karle, I. L., Dragonette, K. S. and Brenner, S. A, *Acta Cryst.*, 1965, **19**, 713.
2. Romain, P., *Bull. Soc. Franc. Mineral.*, 1952, **75**, 447.

AN NMR STUDY OF SPIN-LATTICE RELAXATION AND MOLECULAR ASSOCIATION IN ORGANIC SOLUTIONS

SPIN-LATTICE relaxation is known to be a process in which energy exchange takes place between the nuclear spin system and the lattice tending to bring the systems into equilibrium to a common temperature. The process is exponential with a time constant T_1 which is the relaxation time that is inversely proportional to the probability of transition between the nuclear energy levels, brought about by spin-lattice interaction. An important mechanism for producing these transitions is the nuclear magnetic dipolar interaction of intra- as well as inter-molecular type. For liquids, T_1 can be expressed as:

$$\frac{1}{T_1} = \left(\frac{1}{T_1}\right)_{\text{rotational}} + \left(\frac{1}{T_1}\right)_{\text{translational}}. \tag{1}$$

Bloembergen, Purcell and Pound[1] have given contribution to T_1 due to rotational and translational terms. The rotational term obtained by BPP[1] was later modified by Kubo and Tomita[2] and Solomon[3] and is given by

$$\left(\frac{1}{T_1}\right)_{\text{rotational}} = \frac{2\pi\gamma^4 \hbar^2}{b^6 kT} \eta a^3. \tag{2}$$

where '*b*' is the interproton distance, η is the coefficient of viscosity and '*a*' the molecular radius. The translational contribution is given by

$$\left(\frac{1}{T_1}\right)_{\text{translational}} = \frac{3\pi^2\gamma^4 \hbar^2}{kT} \eta N \tag{3}$$

where N is the number of protons per cc.

Putting the above values in equation (1), we get

$$\left(\frac{1}{T_1}\right) = c_1\eta a^3 + c_2\eta N \tag{4}$$

where

$$c_1 = \frac{2\pi\gamma^4 \hbar^2}{b^6 kT} \text{ and } c_2 = \frac{3\pi^2 \gamma^4 \hbar^2}{kT}.$$

Giulotto, Lanzi and Tosca[4] and Kher and Modak[5] have studied nuclear relaxation and molecular association in certain organic liquid mixtures. They used CCl_4 and CS_2 as one of the liquids which does not contain any proton. Hence, it was thought desirable to study association properties of two liquids both of which contain protons.

EXPERIMENTAL PROCEDURE

The experimental procedure is essentially the same as adopted before[5] with some modifications.[6]

The compounds aniline, isopropyl alcohol and xylene (all of BDH AnalaR grade) were doubly distilled before use. Different solutions of these purified chemicals were prepared by changing the molar concentration of xylene and isopropyl alcohol from 0 to 100% with aniline. The viscosity of these solutions was measured using Ostwald's viscometer. The viscosity of these solutions is not very high, hence τ_c, the correlation time for the rotation of the molecules will be low enough to make $2\pi\nu_0\tau_c << 1$. where ν_0 is the resonance frequency. Hence, the longitudinal and transverse relaxation times T_1 and T_2 respectively are more or less equal.[7]

Exact relaxation time T_1 is not determined but the maximum absorption signal height '*d*' corrected for the concentration of protons is taken proportional to T_1.[6]

Thus,

$$d = \frac{c}{T_1}$$

where *c* is a constance. Hence, from equation (4),

$$d = cc_1\eta a^3 + cc_2N\eta \quad \text{or} \quad d = c'\eta a^3 + c''\eta N$$

where the new constants are given by $c' = cc_1$ and $c'' = cc_2$

or

$$\frac{d}{\eta} = c' a^3 + c'' N. \tag{5}$$

Equation (5) indicates that d/η depends upon '*a*' and 'N'. Since N is constant in our case, the graphs of d/η *versus* concentration of xylene and isopropyl alcohol will reflect changes in molecular radius. Since '*a*' is occurring in the third power, the importance of the first term increases rapidly with increase in '*a*'.

RESULTS AND DISCUSSION

The variation of d/η against the mol. fraction of xylene and isopropyl alcohol is shown in Fig. 1 (*a*) and (*b*) respectively. It is seen that d/η increases from 2·36 to 6·4 for xylene-aniline [Fig. 1 (*a*)] and from 2·36 to 8·3 for isopropyl alcohol-aniline [Fig. 1 (*b*)] as the mol. fraction of xylene and isopropyl alcohol is increased respectively.

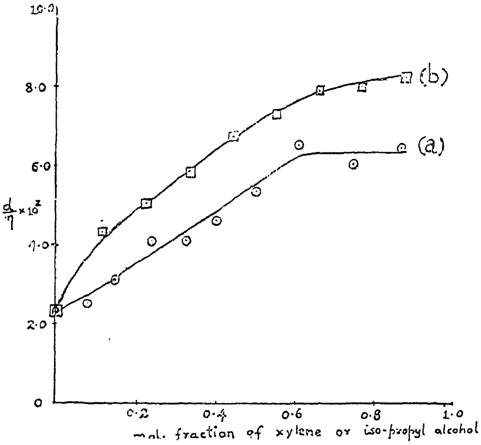


Fig. 1. (*a*) Variation of d/η against mol. fraction of xylene. ○—Xylene-aniline. (*b*) Variation of d/η against mol. fraction of isopropyl alcohol. ☐—Isopropyl alcohol-aniline.

In equation (5), the second term is made constant by choosing the volume proportion of xylene-aniline and isopropyl alcohol-aniline such that N, the number of protons per cc, for all concentrations, remains constant. Hence, changes in d/η can be related directly to '*a*'. Figure 1 (*a*) and (*b*) shows that as the concentration of xylene or isopropyl alcohol increases, d/η and therefore '*a*' increases in the beginning and remains constant beyond 0·68 and 0·66 molecular fraction respectively.

From Fig. 1 (*a*), it is seen that at about 0·7 mol. fraction of xylene and beyond, association is maximum. This clearly shows that the effective molecular radius increases as the concentration of xylene is increased upto about 0·7 mol. fraction. Beyond this concentration, the molecular radius remains nearly constant. The increase in the molecular radius '*a*' can be interpreted as due to molecular association.

Venkateshwarlu and Sastry,[8] using ultrasonic methods, measured the variation of the absorption of the waves with concentration of the same two pairs of liquids. They have attributed the observed peak at about 0·3 mol. fraction of aniline to the N-H bond type association for both cases.

It seems that the N-H bond may be responsible for the association observed in the present investigation.

ACKNOWLEDGEMENT

The authors wish to thank Professor C. Mande, Head of the Physics Department, Nagpur University, Nagpur, for laboratory facilities, Dr. G. V. Asolkar, Dr. P. L. Khare and Dr. R. H. Sahasrabudhe for helpful discussion.

Institute of Science, Nagpur,
V. G. KHER.
K. R. UPASANI.
S. D. WACHASUNDER.

Dept. of Physics, Nagpur University, Nagpur,
SURESH G. MODAK.

January 6, 1971.

---

1. Bloembergen, N., Purcell, E. M. and Pound, R. V., *Phys. Rev.*, 1948, **73**, 679.
2. Kubo, R. and Tomita, K., *J. Phys. Soc. Japan*, 1954, **9**, 935.
3. Solomon, I., *Phys. Rev.*, 1955, **99**, 559.
4. Giulotto, L., Lanzi, G. and Tosca, L., *J. Chem. Phys.*, 1956, **24**, 632.
5. Kher, V. G. and Modak Suresh, G., *Indian J. pure and appl. Phys.*, 1970, **8**, 409.
6. Modak, S. G., Khare, P. L., Mande, C. and Kher, V. G., *Ibid.* (under print).
7. Andrew, E. R., *Nuclear Magnetic Resonance*, Cambridge University Press, 1958, p. 121.
8. Venkateshwarlu, M. and Sastry, Shivarama G., *Indian J. pure and appl. Phyi.*, 1968, **6**, 558.

CRYSTAL DATA OF A CARBONYL COMPLEX OF RUTHENIUM: DICHLORO DICARBONYL *BIS* DIPHENYL ETHYL ARSENE RUTHENIUM-II

[CIS-RU Cl_2 $(CO)_2$ $(PH_2$ ET AS$)_2$]

THE above carbonyl of Ruthenium, synthesised by E. G. Leelamani and G. K. N. Reddy of the Chemistry Department, of this College, was supplied to us for X-ray study. Needle-shaped single crystals of the compound were grown from a solution of a mixture of dichloro methane and methoxy ethanol, by slow evaporation. Suitable crystals were selected and mounted about the *a*- and *b*-axes. Cu Kα (1·542 A.U.) radiation was used. Rotation as well as Weissenberg photographs were taken about the *a*- and *b*-axes. Mounting about the c-axis was not satisfactory, because of the improper development of the crystals about that axis. The values of *a* and *b* were obtained from the rotation photographs. From the Weissenberg photographs a^*, b^*, c^*, α^* and β^* were determined. Using the relations between the direct and reciprocal cell elements,[1] the values of γ^*, c, a, β and γ were calculated. The density of the crystal was determined by the displacement method.

DATA

$a = 10{\cdot}09$ A.U. | $\alpha^* = 84^\circ\ 43'$ | $a^* = {\cdot}1652$
$b = 10{\cdot}41$ A.U. | $\beta^* = 87^\circ\ 17'$ | $b^* = {\cdot}1723$
$c = 16{\cdot}86$ A.U. | | $c^* = {\cdot}09218$

$\alpha = 96^\circ\ 28'$
$\beta = 96$
$\gamma = 116^\circ\ 37'$

Density (experimental) = 1·578 gm/cc
Density (calculated) = 1·597 gm/cc
Number of molecules/unit cell = 2
Systematic absences = Nil

As the intensity data were not measured, it was not possible to come to a definite conclusion regarding the space group. Hence, the space group may be P1 or P$\bar{1}$.

One of the authors (S. V.) thanks the U.G.C. for the award of a Research Scholarship. We are also thankful to Dr. G. K. N. Reddy for supplying the material.

Physics Dept.,
Central College,
Bangalore University,
February 26, 1971.

SARLA VASUDEVAN.
K. N. KUCHELA.

---

1. Buerger, M. J., *X-Ray Crystallography*, p. 360.

A SIMPLE DEVICE TO IMPROVE THE ESTIMATION OF NITROGEN IN STEEL

THE available wet chemical methods[1-10] for the determination of nitrogen in steel are essentially based on converting the combined nitrogen into ammonium salts and estimating the latter. It has been rightly emphasized in all the procedures that the experiments should be carried out in isolated rooms, where the absence of free ammonia in the air is ensured. Our efforts, however, have been directed to bring in the much desirable simplicity of making the estimations possible even in the normal laboratory conditions, without taking recourse to this rather unusual precaution.

A simple attachment has been devised whereby ammonia in the air is trapped and thus prevented from coming into contact with the digested sample solution. The device is a conventional U-shaped absorption tube containing pieces of pumice stone moistened with water and loosely packed with glasswool at both the ends. This is connected to the top portion of the digesting unit through an air-tight rubber cork fitted with bent glass tube. Experience has shown that the device should be fitted immediately after the digestion of the sample is completed and kept on till the solution is transferred to the distillation unit.

The ammonia contents of the air in the laboratory have been intentionally varied and the blanks determined in each case with and without the attachment. In all cases, it has been found (*vide* Table I) that variable blank values are obtained when the device is not used whereas the blank is significantly low and constant with the same in operation. The very close agreement between the values of this blank and that caused by reagents alone clearly establishes that the attachment successfully traps the ammonia in the atmosphere. Its efficacy has further been confirmed by analysing a number of steel samples and solutions containing known quantities of ammonia. Full details giving further particulars will shortly be published elsewhere.

TABLE I

Sl. No.	Blank, % nitrogen	
	With the device	Without the device
1	0·0040	0·0240
2	0·0045	0·0150
3	0·0045	0·0300
4	0·0045	0·0250
5	0·0040	0·0100
6	0·0045	0·0200

Note: The total reagent blank was 0·0040 in all the cases.

Our thanks are due to the Management of the Tata Iron and Steel Company for permitting the publication of this note.

Research and Control Laboratories,
Tata Iron and Steel Company Ltd.,
Jamshedpur-7, *February* 27, 1971.

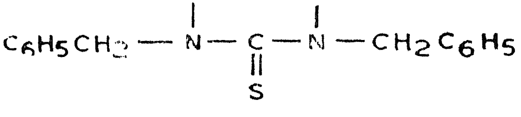
K. S. R. KRISHNAIAH.
S. V. S. S. MURTY.
G. V. L. N. MURTY.

---

1. Artere Seteras, C., *Inf. Quim. Anal.*, 1954, **8**, 11.
2. Lear, J. B., *Dissert. Abs.*, 1954, **14**, 1520.
3. Generozov, B. A., *Zavods. Lab.*, 1955, **21**, 302.
4. Dubox, E. J. and Mayoral, A. H., *An. Assoc. Quim. Argent.*, 1955, **43**, 227.
5. British Iron and Steel Research Association, *I.S.I. Special Report No. 62*, 1959.
6. Indian Standards Institution *I.S. 228*, 1959.
7. Llop Llop, J., *Inst Hierro Y. Acero.*, 1960, **13**, 532.
8. The United Steel Companies Ltd., *Standard Methods of Analysis of Iron, Steel and Associated Materials*, Fifth Revised Edition, 1961, p. 81.
9. British Standards Institution, *B.S. 1121*, Part 39, 1967.
10. Jaudon, Mons. E., *BISRA Open Report*, MG/D/690/70.

CONSTITUTION OF THE NEW THIOUREA DERIVATIVE FROM THE SEEDS OF *SALVADORA OLEOIDES*

THE seeds of *Salvadora oleoides* called 'Khakan' and 'Chhota pilu' in India were examined by us[1] and among the number of compounds symmetrical dibenzyl thiourea, symmetrical dibenzyl urea and a new thiourea derivative, m.p. 180-82° C were isolated. The structure of the new thiourea derivative was tentatively given as symmetrical di(*N*-methyl-*N*-styryl) thiourea. A re-examination of its analytical data and NMR spectrum, necessitates a revision of its structure as symmetrical di(*N*-methyl, *N*-benzyl) thiourea (I). The elemental analysis agrees with this formula $C_{17}H_{20}N_2S$. The compound shows only one maximum at 280 nm in the UV spectrum. The NMR spectrum in $CDCl_3$ has three sharp singlets at 7·35, 5·48 and 1·95 ppm. Integration curve shows that they correspond to 10, 4 and 6 protons respectively. It is remarkable that the most downfield signal is a singlet representing two unsubstituted phenyl groups; usually, it is a multiplet in flavonoids. But it agrees with the NMR of toluene which also shows a singlet for the phenyl group at δ 7·17 ppm[2]. A similar feature has been recently observed in the case of dalbergi-chromene in regard to its 4 phenyl group.[3] The most upfield singlet 1·25 represents two methyl groups which could be either on similar nitrogen atoms or in an aromatic nucleus. The latter is not possible because the aromatic rings are not substituted as shown by the NMR spectrum. Hence, the former possibility exists. The singlet at δ 5·48 ppm could be attributed to four protons of two benzylic methylenes linked to N. Thus, the structure of the compound would be symmetrical di (*N*-benzyl, *N*-methyl) thiourea (I). This is supported by its co-occurrence with dibenzyl urea and thiourea. In NMR spectra, all these benzyl groups have similar values, *e.g.*, dibenzyl thiourea has for the CH_2 a doublet centred at δ 4·81. The new thiourea derivative has not been described in the literature so far and this is the first report of its natural occurrence.



$$C_6H_5CH_2-\underset{|}{\overset{CH_3}{N}}-\underset{\underset{S}{\|}}{C}-\underset{|}{\overset{CH_3}{N}}-CH_2C_6H_5$$

I

Dept. of Chemistry,
University of Delhi,
Delhi-7, *February* 3, 1971.

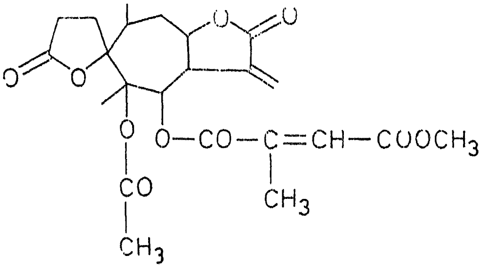
G. R. CHOPRA.
A. C. JAIN.
T. R. SESHADRI.

---

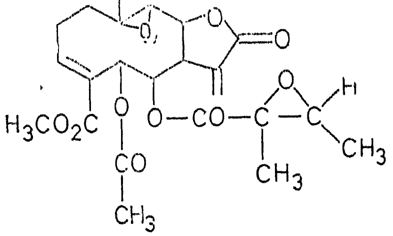
1. Chopra, G. R., Jain, A. C. and Seshadri, T. R., *Curr. Sci.*, 1968, **37**, 121.
2. Bovey, F. A., NMR *Data Tables for Organic Compounds*, Interscience Publishers, 1967, **1**, 169.
3. Mukerjee, S. K., Saroja, T. and Seshadri, T. R., *Tetrahedron*, 1970, **26** (in press).

STRUCTURE OF ENHYDRIN

IN our earlier communications[1,2] we reported the isolation of enhydrin, a new sesquiterpene lactone from *Enhydra fluctuans* (Family: Compositae) and suggested a tentative structure (I) for it based on our limited observations. As the yield of the compound was low and as there were variations from batch to batch of the plant material, we had to rely mainly on the spectral data. We have subsequently isolated more of it and carried out several reactions, and on the basis of the consolidated data, propose a revised structure. The expression (II) now arrived at, seems to satisfactorily explain all the observations.



[I]



[II]

As reported earlier, enhydrin, $C_{23}H_{28}O_{10}$, m.p. 185-86° C, $[\alpha]_D$-55·6°, had an $\alpha:\beta$-unsaturated γ-lactone unit as inferred from UV, IR and NMR data. This was supported by the liberation of formaldehyde on ozonolysis. The compound showed the presence of two double-bonds in quantitative perbenzoic acid titration. The presence of a carbomethoxyl and an acetoxyl groups were clear from the NMR spectra of enhydrin and of its various other derivatives.

Consideration of the molecular formula and elimination of possible alternatives strongly indicated that the compound is a sesquiterpene lactone with an acetoxyl and a carbomethoxyl groups and there should be another hydrolysable group in the form of a C_5 acyloxy function. This was also suggested by the presence of four carbonyl peaks in IR spectrum under good resolution.

Based on a series of chemical transformations, this C_5-acyl unit has now been proved to be present in the form of an epoxytigloyl unit. The formation of a chlorohydrin on treatment with hydrochloric acid and of a vicinal diol with oxalic acid were found to involve this C_5-acyl chain and thus there were clear evidences to show the presence of an epoxide group in the C_5-acyl chain. This structural unit also corresponded with the appearance of a (M^+-116) peak in the mass spectrum. Alkali titration of the parent compound indicated the presence of four hydrolysable groups arising from the lactone, acetoxyl, carbomethoxyl and epoxytigloyl units. All these observations made it necessary to revise the tentative structure (I).

The above functional groups accounted for nine out of the ten oxygen atoms present in enhydrin. That the remaining oxygen was neither a free hydroxyl nor a ketone was clear from spectral data and chemical reactions. The presence in the NMR spectrum of a sharp signal at 1·71 δ for three protons could be attributed to a methyl group attached to a carbon atom bearing an oxygen atom in the form of an ethereal link. This observation indicated that the tenth oxygen might be present as a second epoxide unit. This is accommodated in structure (II) most satisfactorily.

Full details of the study of enhydrin will be published elsewhere.

Dept. of Chemistry, N. R. KRISHNASWAMY.*
University of Delhi, T. R. SESHADRI.
Delhi-7, T. N. C. VEDANTHAM.
March 29, 1971.

---

* Present address: Department of Chemistry, Central College, Bangalore-1.

1. Krishnaswamy, N. R., Seshadri, T. R. and Sharma, B. R., *Curr. Sci.*, 1968, **37**, 94.
2. —, — and Vedantham, T. N. C., *Ibid.*, 1969, **38**, 284.

1, 2-DIHYDROXYBENZENE-4-MONOCHLOROACETYLATE—A SELECTIVE REAGENT FOR TOTAL IRON DETERMINATION

Low concentrations of Zn, Cu (ic), Ag, Cd, Co (ic), Hg (ic), UO_2 and MoO_4 ions interfere at low concentrations (1-20 μg) of iron with various colorimetric methods of iron estimation.[1-3] With 1, 2-dihydroxybenzene-4-monochloroacetylate, which has not been used previously for iron estimation, these ions do not interfere even when present in concentrations higher than are usually encountered in biological materials. The reagent forms a red-coloured chelate with iron in alkaline medium. It is also capable of estimating total iron without pre-oxidation or pre-reduction. The colour is stabilised with polyvinyl alcohol (PVA).

Tris 0·2 Molar was found to be the most suitable pH buffer. Strongly acid samples may be neutralized with either NaOH or NH_4OH to pH 7·0. An excess of chelating reagent results in a rapid development of colour; but it also leads to its rapid fading so that stability plateaux is very much condensed. In view of this, a ratio of one part of iron to 10 parts of chelating reagent is required. The absorbance of the iron chelate is found to be maximum at 520 mμ and Beer's law is obeyed in the range of 0-50 μg of iron.

Reagents

(1) 1, 2 - dihydroxybenzene - 4 - monochloroacetylate (0·052% W/V) 0·026 g dissolved in 50 ml water at 50° C.
(2) Polyvinyl alcohol 0·05% (W/V) in water.
(3) 0·2 M Tris (Hydroxyl) methyl amine [2-amino 2-(Hydroxymethyl) propane-1 : 3 diol]—B.D.H. L.R. grade.

For iron standard, 0·07023 g ferrous ammonium sulphate (A.R.) is dissolved in 10 ml of 0·01 N HCl and made up to 100 ml. This gives 100 μg/ml.

Place 1 ml or less of test solution containing 10-50 μg iron in a wide test-tube. Adjust the volume to 1·5 ml with glass distilled water. Add 1 ml of reagent (1). Next add 1·0 ml of PVA, reagent (2). Last, add 6·5 ml of tris, reagent (3). Mix gently and measure the absorbance in a Baush and Lomb Spectronic-20 colorimeter at 520 mμ against the reagent blank. The colour is stable for an hour.

Figure 1 gives the absorbance of the chelate formed with a constant amount of iron and varying amounts of chelating reagent. It is clear that reagent and iron combine in a molar ratio of 3 : 1. Carboxyl, nitroso, azo or imino groups, when present on an aromatic ring in *ortho*-position to a hydroxyl group, tend to form chelates with cations like Fe^{3+} and Cr^{3+}, the chelate metal molar ratio being 3 : 1.[3-4] From the shape of the curve (Fig. 1), it may be inferred that the ferric chelate is highly stable. It is surmized that irrespective of the initial oxidation state, iron in alkaline medium and in the presence of reagent (1) is rapidly oxidised by air to ferric state. The absorbance is 7247 and sensitivity is $80 \cdot 7 \times 10^{-4}$/ cm^2.

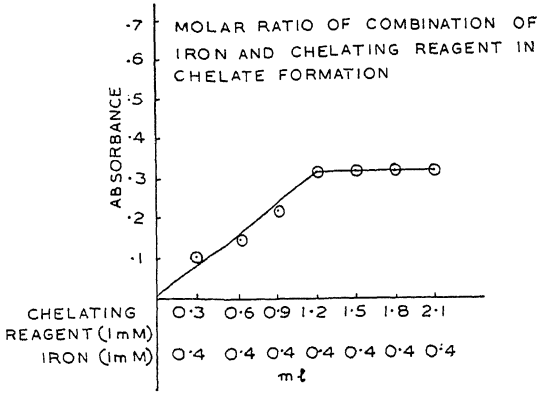


FIG. 1

Recovery of 20 μg of iron in the presence of $\underset{700}{Ca^{2+}}$, $\underset{700}{Mg^{2+}}$, $\underset{1400}{K^{+}}$, $\underset{80}{Zn^{2+}}$, $\underset{80}{Cu^{+2}}$, $\underset{100}{Cd^{2+}}$, $\underset{100}{Cr^{3+}}$, $\underset{100}{Hg^{2+}}$, $\underset{80}{Co^{2+}}$, $\underset{80}{Ag^{2,+}}$ $\underset{80}{Uo_2^{2+}}$ μg respectively shows that only Co^{2+} and Ag^{+} interfere slightly. Considering their range in biological materials, it is concluded that none of these ions interfere in the determination of iron by the proposed method. This has been verified by the recovery of iron using wheat grain and straw, jowar straw and soil clay extracts. In addition, total iron content of five soil clay extracts was determined by both O-phenenthroline method[5] and by the proposed method. A good agreement was found between the values obtained by the two methods for the total iron.

The authors are grateful to Dr. B. N. Tripathi of Defence Science Laboratory for providing the reagent.

Division of Plant
Physiol. and Phytotron,
I.A.R.I., New Delhi-12,
January 16, 1971.

B. Venkateswarlu.
P. C. Pande.

---

1. Smith, G. F. and Richter, F. P., *Phenanthroline Indicators*, G. F. Smith Chemical Co., Columbus Ohio, 1944.
2. *A Handbook of colorimetric Chemical Analytical Methods*, The Tintometer Ltd., Salisbury, England, Part 3.
3. Finar, I. L., *Organic Chemistry : Volume One, The Fundamental Principles*, The English Language Book Society and Longmans Green and Co., Ltd., Box 295, Wimpole Street, London W. 1, p. 749.
4. Foster Dee Snell and Cornelia T. Snell, *Colorimetric Methods of Analysis ; Vol; II: Inorganic*; D. Van Nostrand Co. Inc., New York, 1949, p. 325.
5. Jackson, M. L., *Soil Chemical Analysis*, Prentice Hall, Inc., Englewood Cliffs, N.J., 1967, pp. 284–285 and 390–391.

BACTERIOLOGICAL ACTIVITY IN SALINE, SALINE ALKALI AND ALKALI SOILS

Saline, saline alkali and alkali soils occupy more than one million hectares in Haryana and Punjab. Very little information is available on the microbiological status or nature of microbial activity in such soils. A systematic study of the microflora of this region was, therefore, undertaken and the overall bacteriological activity in these soils is reported in this paper.

Total count of bacteria was done on nutrient agar and the extent of population of nitrogen-fixing bacteria was determined on Ashby's mannitol agar using pour plate method. The counts recorded on the nutrient agar and Ashby's agar are given in Table I. It is clear therefrom that the total count of bacteria per g of soil varies with the pH of the soil. In soils of pH 8·0 to 8·5, the total count per g varied from $5 \cdot 0 \times 10^5$ to $6 \cdot 0 \times 10^6$, in those of pH 8·5 to 9·5 the count was $4 \cdot 0 \times 10^4$ to $5 \cdot 0 \times 10^5$, and in those of pH 9·5 to 10·3, the total count fell to $6 \cdot 0 \times 10^3$ to $4 \cdot 0 \times 10^4$. In marked contrast is the total count observed in normal soils ranging from 12×10^6 to 20×10^6 per g (Table II). Table I also reveals that at pH 8·0 to 8·5, the total count of nitrogen-fixing bacteria per g of soil varies from $7 \cdot 6 \times 10^2$ to $8 \cdot 5 \times 10^2$, at pH 8·5 to 9·5 it varies from $4 \cdot 5 \times 10^2$ to $7 \cdot 6 \times 10^2$ and at pH 9·5 to 10·3 from $3 \cdot 0 \times 10^2$ to $4 \cdot 5 \times 10^2$. The count of *Azotobacter* in normal soil varies from $3 \cdot 7 \times 10^2$ to $17 \cdot 0 \times 10^2$ per g of soil (Table II).

It is obvious from Table I that the total number of micro-organisms decreases in the soil with the increase in pH. Greaves and Jones[1] reported that the total count of bacteria per g of alkali soils varies from $3 \cdot 0 \times 10^4$ to $2 \cdot 0 \times 10^6$.

TABLE I

Total count and count of nitrogen-fixing bacteria from saline and alkali soils

Sr. No.	Location of soil	pH of soil	Conductivity of soils (millimhos/cm at 25° C)	Type of soil	Total count/g. of soil	Count of nitrogen fixing bacteria/g of soil
1	Hissar ..	8·0	10·20	Saline	$6·0 \times 10^6$	$8·5 \times 10^2$
2	Sirsa ..	8·3	10·80	,,	$7·0 \times 10^5$	$8·0 \times 10^2$
3	Narnaul ..	8·5	6·00	Saline alkali	$5·0 \times 10^5$	$7·6 \times 10^2$
4	Sirsa ..	8·9	6·60	,,	$5·0 \times 10^5$	$7·6 \times 10^2$
5	,, ..	9·0	6·60	,,	$8·5 \times 10^4$	$6·5 \times 10^2$
6	,, ..	9·4	7·20	,,	$8·5 \times 10^4$	$6·0 \times 10^2$
7	Hansi ..	9·5	0·72	Non-saline alkali	$6·0 \times 10^4$	$5·0 \times 10^2$
8	Karnal ..	9·5	4·00	Saline alkali	$4·0 \times 10^4$	$4·5 \times 10^2$
9	Chaurali ..	9·7	0·90	Non-saline alkali	$9·7 \times 10^3$	$4·0 \times 10^2$
10	Narnaul ..	9·8	1·08	,,	$8·9 \times 10^3$	$3·7 \times 10^2$
11	Gurgaon ..	9·8	1·14	,,	$8·9 \times 10^3$	$3·7 \times 10^2$
12	Sirsa ..	10·2	2·16	,,	$6·6 \times 10^3$	$3·0 \times 10^2$
13	Mahim ..	10·3	4·20	Saline alkali	$6·0 \times 10^3$	$3·0 \times 10^2$

TABLE II

Total count and count of nitrogen-fixing bacteria in normal soil

Sr. No.	Location of soil	pH of soil	Conductivity of soil (millimhos/cm at 25° C)	Total count/g of soil	Count of nitrogen-fixing bacteria/g of soil
1	Sangrur ..	7·0	3·0	$15·0 \times 10^6$	$7·0 \times 10^2$
2	Karnal ..	7·6	3·3	$12·0 \times 10^6$	$4·0 \times 10^2$
3	Patiala ..	7·7	3·9	$17·0 \times 10^6$	$3·7 \times 10^2$
4	Yamunanagar ..	7·8	4·1	$20·0 \times 10^6$	$17·0 \times 10^2$
5	Chandigarh ..	8·2	3·2	$15·0 \times 10^6$	$4·7 \times 10^2$

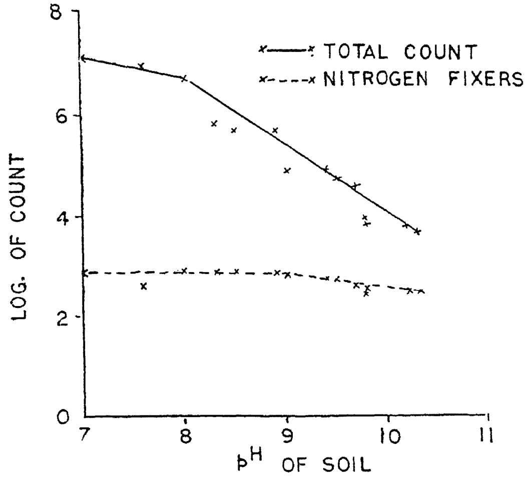


FIG. 1. Relationship between pH of the soil and total microbial population and nitrogen-fixing population

Maximum count of nitrogen-fixing bacteria ($8·5 \times 10^2$ per g of soil) was observed at pH 8·0 from Hissar soil, whereas minimum count ($3·0 \times 10^2$ per g of soil) was recorded for Mahim soil of pH 10·3. Meiklejohn[2] showed that the count of *Azotobacter* is greater than 100 to 9,400 per g of soil in Broadbalk fields whereas Verma *et al.*[3] reported the counts to vary from nil to several thousands per g of soil in Narmada valley. It can also be seen from Fig. 1, that there is a logarithmic decrease in the total microbial population with the increase in the pH of the soil, whereas only slight effect of pH of the soil is reflected on the count of nitrogen-fixing bacteria.

The authors are thankful to Prof. J. V. Bhat of Indian Institute of Science, Bangalore, for critically going through the manuscript.

Dept. of Microbiology, Haryana Agric. Univ., Hissar, *January* 6, 1971.

USHA KHANNA.
Y. I. SHETHNA.*
S. R. VYAS.

---

* Present address : Microbiology and Pharmacology Lab., Indian Institute of Science, Bangalore.

1. Creaves, J. E. and Jones L. W., *Soil Sci.*, 1941, **52**, 359.
2. Meiklejohn, J., *Plant and Soil*, **1965**, **23**, 227.
3. Verma, L. N., Tamboli, P. M. and Dube, J. N., *Indian J. Microbiol.*, 1966, **6**, 1,

A NEW INDIAN HOST OF *XANTHOMONAS ORYZAE*, INCITANT OF BACTERIAL LEAF BLIGHT OF RICE*

SEVERAL alternate hosts have been reported in Japan for *Xanthomonas oryzae* (Uyeda and Ishiyama) Dowson, causal organism of bacterial leaf blight of rice.[1] Yoshimura and Tagami[2] reported that the sub-terranean stem and hairy roots of *Leersia* grasses were important places for overwintering of *X. oryzae* and considered them as primary and secondary sources for initiating the blight in nurseries and fields. In the Philippines, *Leptochloa chinensis, L. panacea* and *Zizinia aquatica* have been found to be susceptible.[3] In India *Cyperus rotundus, C. deformis* and *Oryzae sativa* f. *spontanea*, a wild rice, were reported to be collateral hosts.[4,5] Kulkarni and Thombre suggested wild rice as a potential threat in initiating and spreading the bacterial leaf blight in Maharashtra State.

In view of these findings, studies were initiated to find the host range of the above pathogen among graminaceous weeds that are commonly associated with rice fields. Healthy leaves of twelve different hosts and a susceptible rice variety, Taichung (Native) 1 were pin-prick-inoculated with 48-hour old culture of isolate H 14. Of the 12 hosts inoculated, only *Leersia hexandra* Swartz was found to be susceptible. Disease symptoms developed rather late on *L. hexandra*, generally 14 to 21 days after inoculation, compared to seven days in the susceptible check (Fig. 1). In the former, the spots were restricted and remained necrotic with no water-soaked area along the borders, similar to the reaction on moderately resistant rice varieties. Upon microscopic examination, bacterial streaming was present but was less profuse in *L. hexandra* than in Taichung (Native) 1.

The pathogen was re-isolated from the new host and checked for its authenticity by pathogenicity and phage tests (Table I).

The results clearly show that the organism re-isolated from *L. hexandra* is *X. oryzae*, which is a new host record in India. However, close observations of the plants in nature have failed to reveal infected leaves. Thus, its role in perpetuation of *X. oryzae* is not known, but research is in progress to determine if the bacterium survives in the sub-terranean stems and roots.

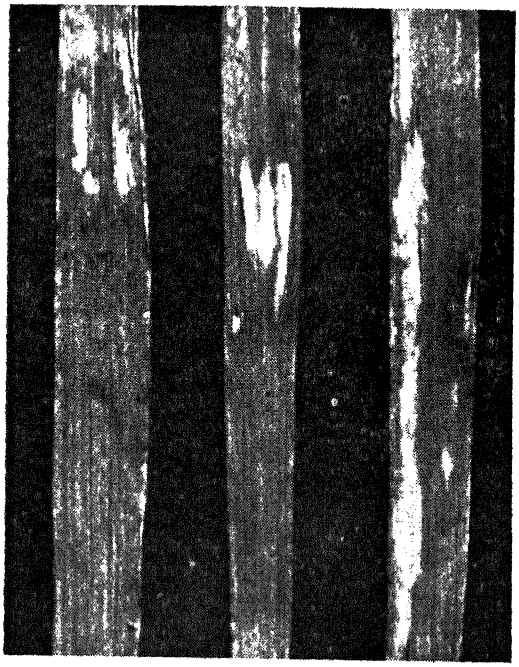


FIG. 1. Symptoms on leaves of *Leersia hexandra* after pinprick inoculation with *Xanthomonas oryzae*.

The authors thank the Indian Council of Agricultural Research and U.S. Agency for International Development for providing facilities for this work.

All-India Co-ordinated
Rice Improvement
Project,
Hyderabad, *January* 18, 1971.

P. S. RAO.
H. E. KAUFFMAN.

TABLE I

Results of pathogenicity and phage tests

X. oryzae isolate	Host reaction		Phage reaction			
	T (N) 1	*L. hexandra*	XOP 1	XOP 4	XOP 6	XOP 9
H 14 ..	+ (7 days)*	+ (15 days)	+	+	+	+
Isolated from *L. hexandra*	+ (7 ")	+ (15 ")	+	+	+	+

* Days for symptom appearance.

---

* All-India Co-ordinated Rice Improvement Project, Publication No. 14.

1. Tagami, Y. and Mizukami, T., *Historical Review of the Researches on Bacterial Leaf Blight of Rice in Japan*, 1962, p. 191.
2. Yoshimura, S. and Tagami, Y., *Proceedings of a Symposium on Tropical Agricultural Researches*, 1967, p. 25.
3. Anonymous, *IRRI Annual Report*, 1967, p. 93.
4. Chattopadhyay, S. B. and Mukherjee, N., *Curr. Sci.* 1968, **37**, 441.
5. Kulkarni N. R. and Thombre, S. B., *Seminar on Problems of Rice Improvement Held at Poona*, 1969.

A STREAK DISEASE OF *BAJRA* [*PENNISETUM TYPHOIDES* (BURM. f.) STAPF AND HUBB.] IN INDIA

In April-May 1970, in a self-sown plot of *Bajra* [*Pennisetum typhoides* (Burm. f.) Stapf and Hubb] at the Indian Agricultural Research Institute, New Delhi, some plants were observed to be chlorotic, stunted and their leaves showed long chlorotic stripes running the whole length of the leaves. The affected plants produced more tillers and normal but poorly developed heads as compared to healthy plants. The disease was later observed to be present extensively in fodder as well as grain crop in the *Kharif* season. The incidence upto 10% was observed. *Bajra* is an important millet in India; the work was therefore, undertaken to identify the disease and to ascertain the method of its spread.

Sap inoculation tests were carried out with the juice of the affected plants, but the disease could not be transmitted. The disease symptoms were suggestive of a 'Yellows' type of disorder, the transmission tests with the commonly-occurring *Jassid* on *Bajra* in Delhi, *viz.*, *Cicadulina mbila* (Naude) were, therefore, carried out. The healthy insects were fed on the diseased plants for about a week or ten days. They were then transferred to young healthy test plants of *Bajra* variety HB-4. The test plants were covered with chimneys in which 4-6 viruliferous insects were liberated. The insects were transferred serially to other healthy plants after every 3rd or 4th day till they were dead. In the preliminary test, 50 plants were inoculated out of which 15 showed the clear symptoms of the disease and the rate of transmission was 30%. All these tests were carried out in the insect-proof glass-house.

The symptoms of the disease in the inoculated *Bajra* plant start in the young unfolding leaf, as pale specks or stripes of different sizes usually on one side of and parallel to the midrib. These specks subsequently fuse or become crowded involving bigger leaf area which results in broad yellow band running almost the entire length of the leaf. The yellow band may be interrupted at places by green tissues. Later, the chlorotic bands may develop on both sides of the midrib. The new leaf subsequent to this may show a number of well-defined long parallel stripes of almost uniform width running its whole length (Fig. 1). After this, the new emerging leaves, both on the main shoot as well as on the tillers, show only well-defined long chlorotic stripes. These may be present on the leaf-sheath as well. The stripes develop as a result of chlorosis of leaf veins and the midrib of the affected plants.

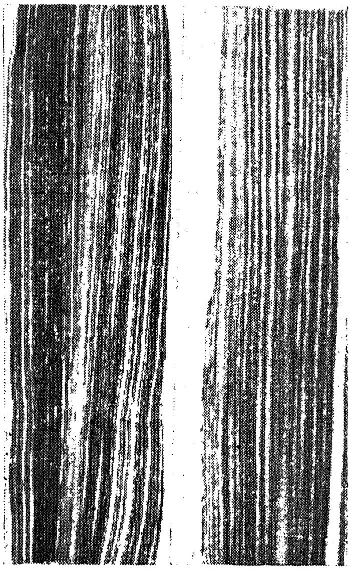


FIG. 1. *Bajra* leaves showing symptoms of streak disease.

The disease was also transmitted successfully to maize producing the typical symptoms of the disease. On the basis of symptomatology and its vector *C. mbila*, the virus has been identified as '*Maize Streak Virus*' reported from East Africa by Storey (1925). This is the first record of occurrence of *Maize Streak Virus* in India and *Bajra* is a new host of the virus.

The authors thank Dr. T. Ishihara, Professor of Entomology, College of Agriculture, Entomological Laboratory, Matsuyama, Japan, for identifying the insect vector.

Division of Mycol. and Plant Pathology,
Indian Agric. Res. Inst.,
New Delhi-12, January 19, 1971.

M. L. Seth.
S. P. Raychaudhuri.
D. V. Singh.

---

1. Storey, H. H., *Ann. Appl. Biol.*, 1925, **12**, 422.

FREE AMINO-ACIDS IN *LIPAPHIS ERYSIMI* KALTENBACK (HEMIPTERA : APHIDIDAE)

Studies on free amino-acid constituents of the Hemipteroid insects are confined to the analysis of the haemolymph and tissues of a few insects of the group Heteroptera, as for example, *Oncopeltus faciatus*,[1] *Rhodnius prolixus*,[2,3] *Belostoma* sp. and *Dysdercus koenigii*[4] and *Belostoma indica, Dysdercus cingulatus* and *Leptocorisa varicornis*.[5] Since no work has been done on any Homopterous insect from this angle, therefore, amino-acid constituents of the adults of *Lipaphis erysimi* have been analysed. The amino-acid contents of the tender leaves of *Brassica juncea*, on which this insect feeds, have been also determined to find out the relationship between the aphid and its host.

The aphids were collected from the plants of *Brassica juncea* and the adults were sorted out and starved for 2 hours. Living aphids weighing 500 mg and leaves of *B. juncea* weighing 1 gm were washed and dried over blotting-paper. Each material was crushed on a separate piece of chromatographic paper and the spots so obtained were quickly dried. The part of the paper containing the material was then cut into small pieces which were wrapped in another piece of filter-paper. The packet containing the material was placed in 90% ethanol for about 2 hours after which the packet was removed from alcohol and discarded. The ethanolic extract of each material was directly applied to a sheet of Whatman No. 1 filter-paper with the help of glass capillaries. Two-dimensional chromatograms were prepared in *n*-butanol, acetic acid, water (4 : 1 : 1) and phenol, water (4 : 1). The amino-acids were located with 0·2% ninhydrin (W/V) in water-saturated *n*-butanol. The amino-acids of the chromatograms of unknown materials were identified by comparing them with the chromatograms of standard known amino-acids which were prepared under similar conditions for comparison.

Fifteen amino-acids, namely, alanine, arginine, aspartic acid, cystine, glutamic acid, histidine, isoleucine, leucine, lysine, proline, serine, threonine, tryptophan, tyrosine and valine are detected in the leaves of *B. juncea* from which the aphids suck their food. Except lysine all the remaining fourteen amino-acids present in the leaves of *B. juncea* are found in the homogenate of the adults of *L. erysimi*. These are apparently obtained by the aphid from its food. The absence of lysine in the aphid indicates that this amino-acid is probably not required by the insect or it is used up in the formation of tissue proteins. In addition, γ-amino-butyric acid, glycine and two unidentified ninhydrin positive compounds are also present in the aphid. Glutamic acid can be metabolised to γ-amino-butyric acid by decarboxylation.[6] Since glutamic acid is available in the leaves as well as in the aphid in high proportions, it is very likely that γ-amino-butyric acid may have been metabolised from glutamic acid in the tissues of the aphid. The absence of glycine and of two unidentified ninhydrin positive compounds in the leaves suggests that these compounds have been synthesised in the insect body. Glycine can be readily synthesised by most insects except Dipterous.[6] Nagayama *et al.*[7] have demonstrated that glycine is synthesised from alanine in the posterior part of the silk glands of *Bombyx mori* as a result of transamination.

U.P. Inst. of Agric. Sci.,
Kanpur-2, January 8, 1971.

A. P. Saxena.

---

1. Pratt, J. J , *Ann. Entomol. Soc. America*, 1950, **43**, 573.
2. Harington, J. S., *Parasitology*, **1961**, **51**, 309.
3. Pickett, C. and Friend, W. G., *Canadian J. Zool.*, 1966, **44**, 241.
4. Pant. R. and Agarwal, H. C. *J. Insect Physiol.*, 1964, **10**, 443.
5. Saxena, A. P., "Studies on free amino-acids in the developmental stages of insects," *Ph.D. Thesis*, Lucknow University, India, 1969.
6. Chefruka, W., *The Physiology of Insects*, Morris Rockstein, ed., Academic Press, New York, 1965. **2**.
7. Nagayama, H., Muramatsu, M. and Shimura, K., *Nature*, 1958, **181**, 417.

REDUCTION IN OIL CONTENT OF CASTOR SEEDS DUE TO STORAGE FUNGI

Castor (*Ricinus communis* L.) seeds are invaded by many fungi during storage.[1,2] The storage fungi reduce the germinability of the seeds.[1] The castor seeds are more valued for their oil content. Hence, the effect of the development of the storage fungi on the seeds on their oil content was assessed.

Healthy castor seeds were surface-sterilized with 0·1% mercuric chloride and treated with spore suspension of five most frequently isolated storage fungi. One lot of surface-sterilized seeds was kept as control without any fungal treatment. The seeds were stored at 75% relative humidity by the method described by Vidhyasekaran and Govindaswamy.[3] After six months of storage, the oil, free fatty acid and reducing sugar content of the seeds were analysed.[4] The lipase enzyme activity of the storage fungi was also assessed.[5]

All the storage fungi reduced the oil content to a very great extent. *Alternaria brassicicola* and *Curvularia pallescens* reduced the oil content to the maximum and these two fungi caused almost complete exhaustion of reducing sugars. But these two fungi did not increase the free fatty acid content of the castor seed appreciably. The other three fungi *Aspergillus flavus, Mucor hiemalis* and *Helminthosporium tetramera* increased the free acid content markedly. These three fungi produced more lipase enzyme in culture (Table I).

TABLE I

Effect of storage fungi on the oil, reducing sugar and free fatty acid content of the castor seeds and lipase enzyme production by the storage fungi

Fungi	Percentage of oil content	Percentage of reducing sugars	Percentage of free fatty acids	Lipase enzyme activity in units
Aspergillus flavus Link.	22·6	0·20	2·01	559
Alternaria brassicicola (Schw.) Wiltshire	14·8	0·04	0·58	71
Curvularia pallescens Boedijn	16·4	0·08	0·64	69
Mucor hiemalis Wehmer	28·8	0·46	2·41	301
Helminthosporium tetramera McKinney	24·6	0·26	1·24	100
Control	40·5	1·51	0·56	..

The reduction in oil content due to storage fungi has been reported in groundnut by Lalithakumari *et al.*[6] The reduction in oil content may be either due to the inhibition of the synthesis of oil in the seeds or due to the degradation of the oil. Sahasrabuddhe and Kale[7] reported that the oil is synthesized by condensation of carbohydrates, especially the reducing sugars. The reduction in reducing sugars in the fungi-infected seeds suggested that the sugars are utilized by the fungi. It is well known that most of the fungi prefer reducing sugars for their growth.[8] Although the formation of free fatty acids did not correlate directly with the reductions in oil content in case of *Alternaria brassicicola* and *C. pallescens*-infected seeds, in case of the other three fungi-infected seeds, it may also be a cause for the reduction in the oil content. The lipolytic activity of the seed-borne fungi has been reported.[9]

Division of Plant Pathology,
Agric. College and Research Institute,
Coimbatore-3, *January* 22, 1971.

D. LALITHAKUMARI.
P. VIDHYASEKARAN.
C. V. GOVINDASWAMY.
SABITHA DURAISWAMY.

---

1. Jain, J. P. and Patel, P. W., *Indian Phytopath.*, 1969, **22**, 209.
2. Lalithakumari, D., Govindaswamy, C. V. and Vidhyasekaran, P., *Madras Agric. J.* (In press).
3. Vidhyasekaran, P. and Govindaswamy, C. V., *Indian Phytopath. Soc. Bull.*, 1968, **4**, 71.
4. *Official Methods of Analysis of the Association of Agricultural Chemists*, Benzamin Franken Station, Washington, 1960, p. 832.
5. Bier, M., In *Methods in Enzymology—I*, Academic Press Inc., New York, 1955, p. 627.
6. Lalithakumari, D., Govindaswamy, C. V. and Vidhyasekaran, P., *Indian Phytopath.*, 1970 (In press).
7. Sahasrabuddhe, D. L. and Kale, N. P., *Indian J. Agric. Sci.*, 1933, **3**, 57.
8. Lilly, V. G. and Barnett, H. L., *Physiology of Fungi*, McGraw-Hill Book Co., New York, 1951, p. 464.
9. Nagel, C. M. and Semeniuk, G., *Plant Physiol.*, 1947, **22**, 20.

A METHOD OF INDUCING AWNLESS CONDITION IN RICE BY CHEMICAL MUTAGENESIS

AWN in rice is a filiform extension of varying lengths from the keel (middle nerve) of the lemma. The genetics of this character involves several postulates and its development is affected by the season, root pruning and level of polyploidy. Generally, awns are always considered to be an undesirable character in rice, as they create problems during handling and milling of the paddy and are also associated with shattering. Yet in certain cultures, considered as a useful source of germplasm since they possess desirable traits like higher protein content, resistance to water-logging or diseases, awns may be present and have to be eliminated.

At the Central Rice Research Institute, two such cultures were isolated from the breeding material, namely, an extract of an interspecific back-cross progeny between *Oryza glaberrima* and *Oryza sativa* and another from a cross between a *japonica* rice and a wild rice from Madagascar, wherein the plants had prominent awns, possessed higher protein content and also tillering ability. Therefore, an attempt was made to find a suitable method for eliminating the awns, keeping as far as possible the rest of the characters unchanged. Since the genetics of the inheritance of awning is reported to be complicated such elimination through hybridization was avoided and mutation breeding was preferred as an alternative route. Besides, since one of the crosses involved an interspecific hybrid between *O. sativa* and *O. glaberrima* which normally gives completed sterility in the F_1, the back-cross progeny selected would give semisterile hybrids and hence hybridization with awnless cultures had to be avoided. Hence this homozygous culture from the back-cross progenies was mutagen-treated. Since physical agents, namely, ionizing radiation would possibly drastically affect other desirable traits through chromosome damage, the seeds were subjected to chemical mutagenesis. The chemicals used were hydrazine and hydroxylamine. The reasons for selecting these two chemicals are as follows: In a project current at this Institute on the studies on chemical mutagenesis of rice, several chemicals were tried on various genotypes. The observations showed that the recessive alleles of the genes for awning in the genotypes were rarely found in them after treatment by the well-established chemicals like diethyl sulphate. In this connection, the study on mutagen specificity by Raut[1] was availed. He compared the mutation specificity of hydrazine and hydroxylamine on Lycopersicon and showed that a number of genes are particularly sensitive to hydrazine in contrast to hydroxylamine. He had stressed on the differential effectiveness of both these base specific chemicals in the induction of mutation in a higher plant as contrasted to their application to micro-organisms. However, he had not tried a combination of these two. Therefore, the experiment was designed to see if *sequential* treatment with the two mutagens of different specificity would give novel or useful mutants.

Dehusked seeds of the above cultures were presoaked for 12 hours in distilled water and were treated with hydroxylamine and hydrazine at 18° C. In two experiments, a *sequential* treatment of hydroxylamine and hydrazine for 6 hours each was tried. The details of the treatment are given in Table I. As can be seen from Table I there is little difference in the toxicity among the chemicals when tried separately and in combination. The seeds were then washed in running water and transferred to flat pans. The M_1 plants were all alike and did not show any conspicuous change in their morphology. The M_1 plants were bagged during flowering and the first four panicles were harvested separately and the M_2 population was grown in single plant progenies. The M_2 cultures did not show any

TABLE I

	Genotypes	Chemicals treated	Comcn.	Duration of treatment	No. seeds treated	No. M_1 plants	No. M_2 cultures with awnlessness
1	(Gl. 1 × Ac. 5627) × Gl. 1	HA	1%	12 hr.	50	11	3
		HZ	1%	12 hr.	50	11	5
		HA+HZ	1%+1%	6 hr.+6 hr.	50	10	2
2	Japonica × Madagaskar	HA+HZ	1%+1%	6 hr.+6 hr.	50	9	2

HA = Hydroxylamine, HZ = Hydrazine

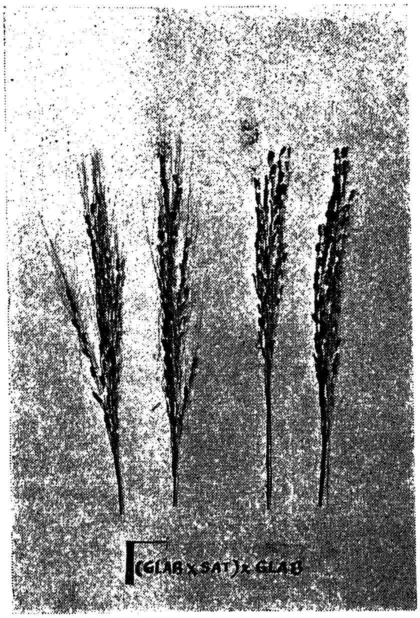


FIG. 1. Panicles of awned (left) and awnless mutants (right).

chlorophyll mutation during the seedling stage. The M_2 population was screened for isolating awnless types and it was observed that these two chemicals could give an appreciable number of the desired mutant (Fig. 1) besides inducing mutation at other loci like non-shattering and culm shortening in both the genotypes treated. The mutants bred true in the M_3 generation. The above findings suggest that such chemical treatments can help in the removal of awns efficiently within a short time and since the chemicals are easily available and cheap, the technique can be repeated by other workers.

This research has been financed in part by a grant made by the United States Department of Agriculture under PL 480. The authors are thankful to Dr. S. T. Padmanabhan, Director, for providing facilities, and Shri S. Sampath, Cytogeneticist, for discussion.

Central Rice Res. Inst., Cuttack-6,
January 21, 1971.
S. N. RATHO.
P. J. JACHUCK.

---

1. Raut, R. N., *Proc. Symposium on Radiations and Radiomimetic Substances in Mutation Breeding*, BARC, Trombay, 1969, p. 38.

REVIEWS AND NOTICES OF BOOKS

Annual Review of Microbiology, Vol. 24. (Annual Reviews, Inc., 4139, El Camincway, Palo Alto, California, 94306), 1970. Pp. ix + 624. Price $ 10.00 ; Foreign $ 10.50.

The underlying theme of this series is to select topics of current interest and review others covering a wide field periodically. Volume 24 of 1970 has thus served eminently both the purposes. Take for example, the review on "Metabolism of Single Carbon Compounds" by Ribbons, Harrison and Wadzinski and that of Shapiro and Stadtman on "The Regulation of Glutamine Synthesis in Microorganisms". Whereas the former has brought into focus the recent work on methane and other organisms capable of metabolising single carbon, especially reduced single carbon substrates, the latter has achieved the objective of sifting from the literature of the past two decades all the pertinent information on the regulation of some primary processes in nitrogen utilization by microorganisms in general and *Escherichia coli* in particular.

Covered in these 569 pages are other seventeen reviews on a variety of topics like: "Energy Yields and Growth of Heterotrophs; Unique Biochemical Events in Bacterial Sporulation; Microbiology of Unconjugated Pteridines; Metabolism and Function of Spermine and Related Polyamines; Microbial Biosynthesis of B_{12}-like Compounds; Saprophytic Coryneform Bacteria; The Regulation of Phage Development; The Genetics of Animal Viruses; The Genetic Basis of Antibody Specificity; *Clostridium perfringens* Food Poisoning; Immunological Enhancement as Studied by Cell Culture Techniques; Bacterial Cytochromes; Functional Aspects; The Evolution of Bacterial Enzyme Systems; Reconstitution of Viruses; Virus-Induced Chromosome Abnormalities; Effect of Virus Infections on the Function of the Immune System; Myxovirus Ribonucleic Acids". Reference has also been made in the volume to other reviews which appeared in 1970 in other periodicals. Of considerable interest to microbiologists would be the prefatory chapter, written by Professor Ernest Pringsheim on his own personal and scientific development and his contributions *vis-a-vis* to the development of General Microbiology. The series has continued to serve the purpose intended and the volume is heartily recommended for adoption and use.

J. V. B.

Biology of Aphid Parasites (Hymenoptera : Aphididae) with Respect to Integrated Control, Vol. VIII. By P. Stary. (Published by Dr. W. Junk, Publishers, 13, Van Stolk Weg, The Hague, Netherlands), 1970. Price : Dutch Guilders 130 or U.S. $ 36.10.

This monumental work, the first of its kind on Aphidiid parasites gives very valuable information collected from published literature as well as from the author's own experience on Aphidiid fauna. The first five chapters which condense essential information right from searching, collecting, selecting, rearing, preserving up to mounting, along with diagnostic characters and morphology of Aphidiid parasites of aphids, with a very useful world list of genera and subgenera together with keys for their separation are invaluable for any workers in this field of entomology. Chapter VI, with ample illustrations drawn from both published literature and the author's own work, is indeed a very comprehensive account of the bionomics and life-history of this group of parasites. The next three chapters dealing with phylogeny of aphids and their parasites, classification of faunistic complexes of the world, tracing the origin and mapping their distribution, details of foci of aphid infestations as well as distribution and dispersal of parasites, make very interesting reading. Chapter X deals with natural limitation of aphids and elaborates the role of parasites in the ecosystem, this information being very useful in considering any integrated control measures. The last three chapters devoted to programmes of biological control, integrated control and multilateral control of aphids are instructive, informative and thought-provoking. Integrated control, multilateral control and biological control have been well defined and elaborately discussed. The photographs and other illustrations are of great assistance in understanding the theme. 1,343 references cited by the author add considerably to the usefulness of the book. The author on the whole should be congratulated for producing such a useful publication. All entomologists and particularly those working on aphids and their parasites are deeply indebted to Dr. Stary for publishing this book. Only an author with varied experience like Dr. Stary could have compiled it.

Indian Station, V. P. RAO.
Commonwealth Institute of
Biological Control, Bangalore-6.

Concepts in Physical Science. Preliminary edition, paper bound, size 21 cm × 27 cm. Director O. P. Puri. (Addison-Wesley Publishing Company, West End House, 11, Hills Place, London W 1, England), 1970. Pp. xvi + 399. Price 61 *sh*.

Experiments in Physical Science. Preliminary edition, paper bound, size 21 cm × 27 cm. Director O. P. Puri. (Addison-Wesley Publishing Company, West End House, 11, Hills Place, London W 1, England), 1970. Pp. x + 83. Price 26 *sh*.

In the modern age which is witnessing rapid developments in science and technology, one can consider himself as educated only when he acquires that amount of basic knowledge which will enable him to understand and appreciate these developments. Thus the need to combine the sciences with the humanities in courses designed for liberal arts students has been well recognized and emphasized by educationists. Under the broad headings of physical science and life sciences, universities in advanced countries offer courses devoted to physics, astronomy, geology, biology, chemistry, biochemistry, etc.

The two books under review on *Concepts* and *Experiments* in physical science have been prepared by a team of seven members on the staff of the Co-operative General Science Project, under the Directorship of Professor O. P. Puri. The contents in the two texts have been developed from course materials taught over a period of three years to liberal arts students in Clark College, Atalanta, Georgia.

They include concepts and historical development of mathematics from ancient times to the modern age of cybernetics and computers; Concepts of motion from Aristotelian to Apollo 11; the universe and its architecture, developments in astronomy; matter and materials including semiconductors and polymers; energy and power including that of the Sun, the atom, and the nucleus; particles in motion; light, lasers and holography; the earth in time and space. The coverage is thus wide, the presentation is simple and essentially non-mathematical and the marginal illustrations and photogravures are effective.

The companion volume is a laboratory manual containing 20 experiments specifically designed for students taking this course. These books can be recommended as texts in Indian universities offering science courses for students of humanities. The first book should interest the lay-scientific reader also. A. S. G.

Probability and Statistics. By Harry Lass and Peter Gottlieb, (Addison-Wesley Publishing Company, Inc., West End House, 11, Hills Place, London W 1, England), 1971. Pp. ix + 470. Price 121 *sh*.

This text-book provides a unified treatment of probability theory and statistics using a consistent notation. The statistical topics are presented as practical applications which follow readily from probability theory. The fundamentals are discussed in a thorough manner so that the student user gets the basic understanding to follow the different special techniques employed in statistics.

The material in this text has been tried and found suitable for a six-semester-hour course on the subject for engineering students. A systematic development of the subject is arranged under the chapter headings: Set Theory and Boolean Algebra, Combinatorial Analysis, Discrete and Continuous Probability Theories, Properties of Statistical Samples, Parametric Point Estimation and Parametric Interval Estimation, Order Statistics and Non-Parametric Methods, Hypothesis Testing.

A hundred-page appendix on mathematical preliminaries makes the book nearly self-contained. Original and carefully designed problems are given at the end of each chapter to enable the student understand the various concepts introduced in the text. A. S. G.

The Fat-Soluble Vitamins. Edited by H. F. DeLuca and J. W. Sutte. (The University of Wisconsin Press, Box 1379, Madison, Wisconsin 53701, USA), 1970. Pp. xvi + 531. Price $ 15.00.

The role that vitamins play in human health and disease has been too well recognized and they in one form or another have become an essential part of man's diet and medicine. But the exact function of the vitamins and their metabolites, their mechanism of action especially at the cellular level have yet to be elucidated and they have become subject of intense investigation in recent years. The pace of research has been accelerated by the availability of new experimental tools such as radiochemical forms of vitamins, techniques such as chromatography, NMR and mass spectroscopy, etc. Further, there are new problems connected with indirect effects of vitamins. Thus, for example, the part that vitamin A plays in controlling bone growth, maintaining epithelial tissues, and forming visual pigments is fairly well known. Now, it is being found that vitamin A has a role in reproduction also either directly or indirectly (p. 267).

These new fields of investigation on fat-soluble vitamins D, A, E and K, form the content of the present volume. It is a symposium of papers which bring out the results of recent researches utilizing a much-needed interdisciplinary approach to the subject. The thirty odd studies included in this volume are contributions by nearly fifty working scientists on the subject at a symposium organized in 1969 at the University of Wisconsin in honour of Professor Harry Steenbock (1886-1967) whose pioneering work on the fat-soluble antirachitic vitamin is well known.

There are 13 papers on vitamin D, 8 papers on vitamin A, and 6 each on vitamins E and K, besides three clinical reports. The publication should be of particular interest to students of nutrition, physiology, biochemistry, pharmacology and medicine. A. S. G.

ANNOUNCEMENTS

Institution of Chemists (India)—Associateship Examination, 1972

The Twenty-second Associateship Examination of the Institution of Chemists (India) will be held in November, 1972. The last date for Registration is 30th November, 1971. The Examination is recognised by the Government of India as equivalent to M.Sc. in Chemistry for purposes of recruitment of Chemists.

Further enquiries regarding this and for Membership may be made to the Honorary Secretary, Institution of Chemists (India), Chemical Department, Medical College, Calcutta-12.

Award of Research Degrees

Banaras Hindu University, Varanasi, has awarded the Ph.D. Degree in Metallurgical Engineering to Shri C. Suryanarayana Shri N. R. Pillai, Shri B. Prasad, Shri Ashok Mohan and Shri G. P. Tiwari.

The M.S. University of Baroda has awarde the Ph.D. degree in Mathematics to Shri V. M Shah.

Osmania University, Hyderabad, has awarde the Ph.D. degree in Botany to Shri A. Narsin Rao and Ph.D. degree in Physics to Shri I Ramabrahmam.

Utkal University has awarded the Ph. degree in Botany to Shri M. V. Nagaraja Set

S.V. University, Tirupati, has awarded t Ph.D. degree in Botany to Shri K. Madhava Rao.

Books Received

General Topology. By Stephen Willard. (Ad son-Wesley Pub. Co., Reading, Massach setts), 1970. Pp. xii + 369. Price 126 *sh*

Experiments in Physical Science (Prelimin Edition). By O. P. Puri (Addison-Wesley P Co., Reading, Massachusetts), 1970. Pp. : 83. Price 26 *sh*.

Concepts in Physical Science. (Prelimir Edition.) By O. P. Puri. (Addison-We Pub. Co., Reading, Massachusetts), 1 Pp. xv + 399. Price 61 *sh*.

2776-71. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.

U^{234}/U^{238} AS A TOOL FOR DATING MARINE SEDIMENTS

T. M. KRISHNAMOORTHY, V. N. SASTRY AND T. P. SARMA
Health Physics Division, Bhabha Atomic Research Centre, Bombay-85

ABSTRACT

A method for dating the marine sediments using the decrease of U^{234}/U^{238} activity ratio in the calcium carbonate phase has been developed. A selective leaching agent NH_4Ac-HAc buffer is used which attacks only the calcium carbonate phase and very little of the other phases. The rate of sedimentation for the core, M-230 (Lat. 23° 10′ N, Long. 67° 50′ E) from Indian Ocean is found to be 1·16 mm/1,000 yrs by this method. The calculated ionium value for the particular water column depth and for the typical composition of the top layer of the sediment 1·58 dpm/g, agrees very well with the actual value of 1·28 dpm/g observed, considering the uncertainties in the parameters used.

INTRODUCTION

POTRATZ (1955) and Barnes *et al.* (1956) observed increase of the ionium to uranium ratio with increasing depth in coral limestone cutting of Eniwetok atoll contrary to the decrease of ionium to uranium ratio found for deep sea sediments. Also, Barnes *et al.* (1956) reported that ionium is remarkably absent in freshly precipitated calcium carbonate deposits and suggested using the ionium growth for dating marine carbonates. Blanchard *et al.* (1967) concluded that dating by uranium disequilibrium measurements is applicable to fossil corals and other fossil marine carbonates that have formed and have remained in a marine environment. Further, the discovery of high U^{234}/U^{238} activity ratios in natural waters by Cherdyntsev (1955) led to a serious study of the uranium isotopes disequilibrium in other media also, which resulted in the discovery of 15% excess of U^{234} over its parent U^{238} in sea-water by Thurber (1962). Later, Thurber *et al.* (1965 *a*) and Broecker and Thurber (1965) found excess U^{234} in recently-formed marine carbonates, oolites and corals and suggested the feasibility of using this excess 15% U^{234} for calculating the absolute ages of marine carbonates. Marine sediments from deep oceans contain several components: calcium carbonate, clays, detrital matter, etc., in varying amounts. The detrital uranium may have U^{234}/U^{238} ratio equal to or less than 1 (Ku-Teh-Lung, 1965). Thus, when measurements are made of U^{234}/U^{238} on total sediments, one obtains values nearer 1, if the detrital fraction is significant by weight. In the present work, an attempt is made to use the decrease in U^{234}/U^{238} activity ratio in the calcium carbonate phase of the marine sediments by developing a suitable leaching agent which does not attack the detrital phase. The material analysed is a core from Indian Ocean collected, on board R.V. Meteor.

ANALYTICAL PROCEDURE

The core sample of about 115 cm length was taken from the station Lat. 23° 10′ N, Long. 67° 50′ E (Gulf of Kutch). It was air-dried and sectioned at 10 cm intervals. The sample size was about 50 g for the uranium isotopes measurement in the calcium carbonate fraction and 5-10 g only for the same in the total sediment.

Calcium carbonate fraction of the sample was selectively attacked with 300 ml 4 N NH_4 Ac-2 N HAc buffer over a period of 24 hr. Leaching was repeated. Preliminary experiments with 50 g of molluscan shell pieces indicated that this amount of buffer solution was sufficient to dissolve the entire carbonate content. The buffer leach was evaporated to dryness, organic matter destroyed and the residue was taken up in 1 N nitric acid. It was oxidised with a little potassium bromate. Radiochemically pure uranium was isolated as per the procedure given by Sarma and Krishnamoorthy (1968).

The thin sources of plated uranium were counted in an alpha spectrometer consisting of a surface barrier detector coupled to an ORTEC low noise preamplifier unit and Nuclear Data 512 channel analyser for an average period of 2,000 minutes.

Sediment samples for total destruction were treated according to the chemical procedures described for the sample dissolution by Sarma (1964) and the rest of the procedure as described above was followed.

RESULTS AND DISCUSSION

Data on the U^{234}/U^{238} ratios in the carbonate fraction and in the total sediment along with per cent calcium carbonate and uranium activity in the carbonate phase are given in

TABLE I

Uranium data in different sections of the core M-230

(Station position : Lat. 23° 10′ N, Long. 67° 50′ E)

Depth cm	Calcium carbonate %	Uranium in leach		U^{234}/U^{238} ratio	
		dpm/g carbonate	dpm/g sediment	In leach	In total sediment
Grab	13·36	4·08 ±0·12	0·54	1·136 ±0·029	..
0–10	15·71	3·29 ±0·15	0·52	1·128 ±0·023	1·005 ±0·033
10–20	5·59	9·64 ±0·24	0·54	1·105 ±0·026	..
20–30	9·50	4·10 ±0·13	0·39	1·078 ±0·036	0·989 ±0·035
30–40	13·89	4·67 ±0·08	0·65	1·067 ±0·036	1·008 ±0·047
80–90	16·90	3·36 ±0·11	0·58	1·035 ±0·019	..

Table I for different sections of the core. From Fig. 1, which gives the decay of the excess activity ratio of U^{234}/U^{238} over the equilibrium value against the mid-points of various sections, the rate of sedimentation is calculated to be 1·16 mm/1,000 years. Since the calcium carbonate in the sediment has oceanic origin, the U^{234}/U^{238} activity ratio in the top layer of the sediment (carbonate phase) should approach the value of 1·15. This is observed for the Grab sample as shown in Table I. Figure 2 represents the typical spectrum of uranium from the acetate buffer leach of 0-10 cm section of the core, M-230.

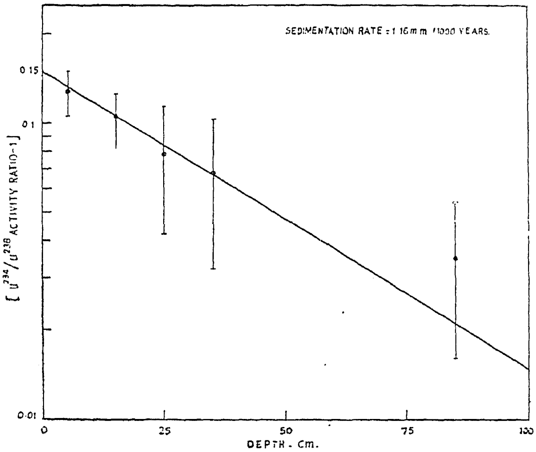


FIG. 1. Decay of excess U^{234} in different sections of the core M-230.

The sedimentation rate 1·16 mm/1,000 years is an extremely low value for the Indian Ocean region. For such low precipitation rates, a high amount of Th^{230} activity of the order of 50 dpm/g is observed in the top layer of Pacific cores (Goldberg and Koide, 1958). The Th^{230} activity observed in the top segment of this core, 1·28 dpm/g is understandable as the depth of the water column at this point is only 25 metres whereas the depths in deep oceans are 3-4 km which increases the production of ionium. Sarma (1964) made model calculations of the expected Th^{230} activity in the top layers of the ocean sediments as a function of the water depths, sedimentation rate and the fraction of detrital and calcium carbonate phases.

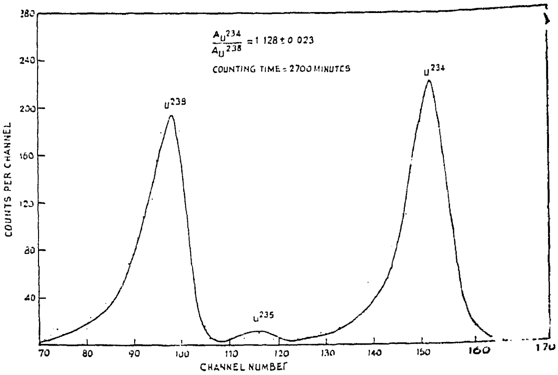


FIG. 2. Alpha spectrum of the uranium from $CaCO_3$ phase of the 0-10 cm section of the core M-230

$$S_{230} = Q_d F_d S_{238,d} + QHNU\lambda_{238}\,\lambda_{232}/rA_u D$$

where

S_{230}, specific activity of ionium, dpm/g

Q_d, U^{234}/U^{238} ratio in the detrital fraction, assumed 1

F_d, detrital fraction

$S_{238,d}$, U^{238} activity in the detrital fraction, dpm/g

Q, U^{234}/U^{238} in sea-water

H, depth of the water column, cm

N, Avogadro number

U, uranium content of sea-water, g U/cm³

λ_{238} and λ_{230} decay constants of U^{238} and Th^{230}

A_u, atomic mass of uranium

D, density on dry basis, g/cm³, and

r the rate of sedimentation in cm/year.

Using the above formula, for M-230 core, the expected Th^{230} activity works out to be 1·58 dpm/g taking $S_{238,d}$ as 1·25 dpm/g of the top segment and F_d as 0·85, whereas the observed value is 1·28 dpm/g which are in good agreement considering the uncertainties in the parameters used for the calculation.

Under anaerobic conditions, high ratios for U^{234}/U^{238} have been reported by Veeh (1967) even in total sediments of the upper continental slope in the eastern Pacific, Gulf of California, when the uranium content is high (4·8 to 39·0 ppm U). In such cases, the decay of excess U^{234} can be followed even in total sediments to determine the sedimentation rates. However, as already pointed out, we are observing U^{234}/U^{238} activity ratios very near 1. This ratio of 1, as well as the consistently small amounts of uranium in the ammonium acetate-acetic acid leach (0·5 dpm/g total sediment) compared to that of uranium from totally destroyed sediment (2·5 dpm/g in the top segment of the core) indicate the selective attack of the authogenic carbonate phase by the buffer. Hence, the method of attacking authogenic carbonate phase as the one reported here above, is of general utility for determining the sedimentation rates using the excess U^{234}/U^{238} activity.

ACKNOWLEDGEMENT

Our thanks are due to Dr. A. K. Ganguly, Head, Health Physics Division, Bhabha Atomic Research Centre, for the useful discussions and the encouragement given.

---

1. Barnes, J. W., Lang, E. J. and Potratz, H. A., *Science*, 1956, **124**, 175.
2. Blanchard, R. L., Cheng, M. H. and Potratz, H. A., *J. Geophys. Res.*, 1967, **72**, 4745.
3. Broecker, W. S. and Thurber, D. L., *Science*, 1965, **149**, 58.
4. Cherdyntsev, V. V., *Tr. III Sessie Komisste Po opredeleniyn absolyutnogo Voziasta*, *Iza.* Akad. Nauk, SSSR, 1955, p. 175.
5. Goldberg, E. D. and Koide, M., *Science*, 1958, **128**, 1003.
6. Ku-Teh-Lung, *J. Geophys. Res.*, 1965, **70**, 3457.
7. Potratz. H. A, Barnes. J, W. and Lang, E. J., "A radiochemical procedure for thorium and its application to the determination of ionium in coral limestone" *U S. At. Energy Comm. Rept*, *LA*, 1845, 1955.
8. Sarma, T. P., "Dating of marine sediments by ionium and protoactinium methods *Ph.D. Thesis*, Carnegie Institute of Technology, Pittsburgh, Pennsylvania, 1964.
9. — and Krishnamoorthy, T. M., *Curr. Sci.*, 1968, **37**, 422.
10. Thurber, D. L., *J. Geophys. Res.*, 1962, **67**, 4518.
11. —, Broecker, W. S., Blanchard, R. L. and Potratz, H. A., *Science*, 1965 *a*, **149**, 55.
12. Veeh, H. H., *Plannet Sci. Letters*, 1967, **3**, 145.

EVALUATION OF ANTIBACTERIAL AND ANTITOXIC IMMUNITY IN CHOLERA*

K. BHASKARAN AND V. B. SINHA
Central Drug Research Institute, Lucknow, India

WITH the realization that current cholera vaccines confer only short-term immunity to the disease, research has been stepped up in various laboratories of the world towards identifying more effective immunizing agents. There are two aspects to be considered, both dependent on the pathogenesis of the disease. While the infecting organism, *Vibrio cholerae*, is strictly confined to the gut where it proliferates, the pathological manifestations of the disease such as severe dehydration and electrolyte imbalance are due to an enterotoxin (choleragen) released by the organisms during growth.[1] Consequently, immune mechanisms should be operative either against the invader restricting its capacity to multiply in the gut or towards the toxin by neutralizing its activity before any harm results.[2] Thus, one has to think in terms of either antibacterial or antitoxic immunity or both in cholera immunology.

Sero-epidemiological evidence obtained from cholera endemic areas has provided clues for further research in this field. One of the features observed in East Pakistan was the inverse relationship between age and susceptibility to the disease, children being more susceptible than adults. Correlated with this were higher titres of a complement dependent vibriocidal antibody in the sera of individuals of older age-groups.[3] It was also seen that the frequency of clinical cholera in familial contacts of cholera cases was lowest among individuals with high vibriocidal antibody levels and increased progressively among persons with lower titres.[4] However, the association of this antibody with immunity to the disease is not yet proved as high titres have been observed in healthy individuals never exposed to cholera antigens and in certain other diseases like brucellosis. Passive protection experiments in mice with antibrucella sera showed that there was no correlation between protection and vibriocidal titres.[5] Further, there is no evidence yet that the vibriocidal reaction as observed *in vitro* is the mechanism for suppression of infection in the human gut.

---

* Communication No. 1641.

Animals immunized with cholera enterotoxin develop toxin-neutralizing antibodies which can be titrated in rabbit ileal loops.[6] Such antitoxins appear also in the sera of patients convalescing from cholera and in healthy individuals resident in endemic areas.[7] Unlike the vibriocidal antibody, antitoxic titres tend to decrease with age and cases of cholera occur in persons with detectable serum antitoxin levels. Woodward *et al.*[8] attribute this to ineffective immunization occurring in nature and expect, as in tetanus, parenteral immunization with toxoid may induce higher and longer lasting levels of antitoxin. There is a possibility that higher levels achieved thus may be protective, as demonstrated in dogs.[9] Particularly interesting in this context is the finding that canine ileum, perfused with blood containing antitoxin, did not respond to challenge with cholera enterotoxin.[10]

Although in theory it appears feasible to design studies in man and animals to determine independently the relative values of antibacterial and antitoxic immunity in cholera, practical difficulties may be encountered. While parenterally-administered, commercial cholera vaccines generally lead to the production of antibacterial antibodies only, certain preparations may contain sufficient toxin to induce the formation of antitoxins as well.[11] In experimental animals, after parenteral immunization with live culture vaccines, which is associated with demonstrable immunity,[12,13] both antibacterial and antitoxic antibodies may appear in the serum[11] rendering interpretation difficult. In contrast, preparations of cholera enterotoxin (choleragen), effectively purified and rendered free from somatic antigenic debris, should induce the production of antitoxin exclusively. Perhaps this is not always easy to achieve as even such purified preparations may occasionally give rise to the formation of agglutinating and vibriocidal antibodies.[14] Another disturbing feature is the high level of reaction observed with such extra pure preparations as manifested by lethal effects in experimental animals.[15]

We suggest here simplified methods for assessment of antibacterial and antitoxic immunity in cholera which do not involve expensive and time-consuming procedures of toxin purification. These methods depend primarily on the use of 'hybrid' strains of *V. cholerae* in which 0 Group I antigens (Gardner and Venkatraman) have been substituted by the 0 antigens of a non-cholera vibrio strain (NCV 165) by genetic recombination, as described previously.[16] Further modifications of the techniques, and the use of streptomycin-resistant mutants, have led to the isolation of such 'hybrids' from three more strains of *V. cholerae* (Inaba, 569 B; Ogawa, Phil 11; and Ogawa, T 50), belonging respectively to Types 1, 3 and 5 of Feeley.[17] These recombinants have been designated as 569B-165, Phil 11-165 and T 50-165 to denote their parentage as well as to indicate 0-165 antigenic structure. As chromosomal transfer in *V. cholerae* appears to be confined to short segments,[18] these hybrids should have retained the chromosomal genetic structure of their parent strains including the region concerned with the synthesis of the enterotoxin; the only change being in the gene cluster determining 0 antigen synthesis (and specificity) derived from 0-165 strains by conjugation.

The broad divergence between *V. cholerae* and the 'hybrid' strains is well brought out by agglutination and vibriocidal tests recorded in Table I. Rabbits immunized with *V. cholerae* strains showed good levels of agglutinins and high titres of vibriocidal antibody in their sera, both specific for *V. cholerae* strains only. Likewise, non-cholera vibrio (NCV 165) and 'hybrid' (58SR-165) strains produced serum agglutinins for all strains which contained 0-165 antigens. However, in vibriocidal tests with these sera (which showed marked 'prozone' effects), only two of the three hybrid strains (Phil 11-165 and T 50-165) were sensitive to this antibody. The other strain, 569 B-165, appeared to be resistant to killing by antibody and complement. Another surprising feature of the tests recorded in Table I was the absence of cross-reaction between 0-165 antisera and test cultures of *V. cholerae* in agglutination tests, which could be expected on the basis of common flagellar antigens. This is under investigation. Mouse protection tests, based on the methods of Pittman and Feeley,[19] are shown in Table II. It will be seen that protection is conferred only against 'homologous' challenge.

The finding that strains of *V. cholerae* and 0-165 'hybrids' derived from them are antigenically distinct and do not give rise to cross

TABLE I

Agglutinin and vibriocidal titres in rabbit sera after multiple parenteral live culture immunization with cholera, non-cholera and 'hybrid' vibrio strains

Strain used for immunization	Agglutinin titre*						Vibriocidal titre					
	V. cholerae			*'Hybrid'*			*V. cholerae*			*'Hybrid'*		
	1	2	3	4	5	6	1	2	3	4	5	6
V. cholerae, Ogawa V58SR, non-motile	2000	2000	4000	0	0	0	4×10^5	8×10^5	8×10^5	0	0	0
V. cholerae, Inaba V65, non motile	4000	2000	4000	0	0	0	2×10^5	8×10^4	8×10^4	0	0	0
Non Cholera Vibrio NCV 165, motile	0	0	0	2000	2000	2000	0	0	0	0	$1{\cdot}6\times10^5$	$1{\cdot}6\times10^5$
'Hybrid' Vibrio 58SR-165, motile	0	0	0	2000	1000	2000	0	0	0	0	$1{\cdot}6\times10^5$	$1{\cdot}6\times10^5$

* Live cultures employed.

Key :

1 = Inaba 569B

2 = Phil 11

3 = T 50

4 = 569 B–165

5 = Phil 11–165

6 = T 50–165

0 = Negative at 50

TABLE II

Mouse protection tests with cholera, non-cholera and 'hybrid' vibrio strains

Immunized with (circ. 3×10^6 cells*)		Challenge (100 LD 50 doses)		
		V. cholerae Ogawa 162/p	*V. cholerae* Inaba 162/p	'Hybrid' 58SR-165
V. cholerae Ogawa 162/p	..	1/16	1/16	16/16
V. cholerae Inaba 162/p	..	4/16	2/16	16/16
Non-cholera vibrio NCV 165	..	16/16	16/16	5/16
'Hybrid' 58SR-165	..	16/16	16/16	1/16

* Live cultures used.

Numerator : Deaths
Denominator: No. challenged

TABLE III

Immunization and challenge schedules to evaluate antibacterial and antitoxic immunity in cholera

S. No.	Immunization		Challenge	Immune-assay
1	*V. cholerae*, Inaba 569B killed vaccine (toxin-free)	..	*V. cholerae* Inaba 569B	Antibacterial
2	'Hybrid' 569B-165 killed vaccine (toxin-free)	..	'Hybrid' 569B-165	do.
3	*Toxoid from *V. cholerae*, Inaba 569B	..	do.	Antitoxic
4	*Toxoid from 'Hybrid', 569B-165	..	*V. cholerae* Inaba 569B	do.
5	1 and 4 or 1 and 3	..	do.	Antibacterial + antitoxic
6	2 and 3 or 2 and 4	..	'Hybrid' 569B-165	do.
7	Live culture vaccine attenuated *V. cholerae*[23]	..	*V. cholerae* Inaba 569B	do.
8	do.	..	'Hybrid' 569B-165	Antitoxic

* 'Syncase culture filtrates, formalin treated.

protection permits their use in investigations designed to assess antitoxic and antibacterial immunity in cholera. In particular, *V. cholerae* strain Inaba 569 B and the 'hybrid' derived from it, strain 569 B-165, are eminently suitable as they produce detectable levels of choleragen and PF toxin during growth in 'Syncase' medium supplemented with sucrose,[20] although this has not yet been assayed quantitatively. These strains may, therefore, be used as source of bacterial cell substance of toxin (toxoid). By virtue of its resistance to the lethal effect of antibody and complement, strain 569 B-165 may be particularly valuable in studies to delineate the role of vibriocidal antibody in cholera immunity.

Table III gives a schedule of immunizing preparations (and combinations), with corresponding challenge strains, to assess antibacterial and antitoxic immunity independently and collectively. Parenteral routes of immunization may deserve priority because of the current interest in toxoid-induced antitoxic immunity. In experimental animal models and human volunteers, the challenge organism may be administered by mouth to mimic natural infection. Estimates of antibody levels in serum and intestine at different times before and after immunization should prove valuable in the assessment of results. The schedule, though drawn up primarily for active immunization studies, can be adapted for passive immunization as well. Changes could also be made to study type-specific immunity[21] and the value of purified antigenic preparations in place of whole cell vaccines.[22]

The authors are grateful to Dr. N. K. Dutta (Haffkine Institute, Bombay), Prof. R. Sen (Serologist, Government of India, Calcutta), and Dr. D. Barua (World Health Organization, Geneva), for providing strains for genetic and other studies reported here. This work was supported by a grant from the World Health Organization.

---

1. Finkelstein, R. A., Norris, H. T. and Dutta, N. K., *J. infect. Dis.*, 1964, **114**, 203.
2. Burrows, W., *Ibid.*, 1970, **121** Suppl., S 58.
3. Mosley, W. H, Benenson, A. S. and Barui, R., *Bull. Wld. Hlth. Org.*, 1968, **38**, 327.
4. —, Shamsa Ahmed, Benenson, A. S. and Ansaruddin Ahmed, *Ibid.*, 1968, **38**, 777.
5. Gangarosa, E. J., De Witt, W. E., Feeley, J. C. and Adams, M. R., *J. infect. Dis.*, 1970, **121** Suppl., S 36.
6. Kasai, G. J. and Burrows, W., *Ibid.*, 1966, **116**, 606.
7. Benenson, A. S., Anisa, Saad., Mosley, W. H. and Ansaruddin Ahmed, *Bull. Wld. Hlth. Org.*, 1968, **38**, 287.
8. Woodward, W. E, Mosley, W. H. and McCormack, W. M., *J. infect. Dis.*, 1970, **121** Suppl., S 10.
9. Curlin, G. T., Subong, A., Craig, J. P. and Carpenter, C. C. J., *Trans. Ass. Amer. Physicians*, 1968, **81**, 314.
10. Curlin, G. T. and Carpenter, C. C. J., *J. infect. Dis.*, 1970, **121** Suppl., S 132.
11. Feeley, J. C. and Roberts, C. O., *Texas Rep. Biol. Med.*, 1969, **27** Suppl. 1., 214.
12. Panse, M. V., Jhala, H. I. and Dutta, N. K., *J. infect. Dis.*, 1964, **114**, 26.
13. Basu, S., Robinson, R. L. and Pickett, M. J., *Ibid.*, 1970, **121** Suppl., S 56.
14. Finkelstein, R. A., *Texas Rep. Biol. Med.*, 1969, **27** Suppl. I, 181.
15. —, *J. infect. Dis.*, 1970, **121** Suppl., S114.
16. Bhaskaran, K. and Sinha, V. B., *Ind. Jour. Expt. Biol.*, 1971 (In press).
17. Feeley, J. C., *J. Bacteriol.*, 1965, **89**, 665.
18. Bhaskaran, K., *Bull. Wld. Hlth. Org.*, 1964, **30**, 845.
19. Pittman, M. and Feeley, J. C., In *Proceedings of the Cholera Research Symposium*, U.S. Govt. Printing Office, Washington, D.C., 1965, p. 163.
20. Finkelstein, R. A. and LoSpatullo, J. J., *J. infect. Dis.*, 1970, **121** Suppl., S 63.
21. Mosley, W. H. *et al.*, *Ibid.*, 1970, **121** Suppl., S 1.
22. Watanabe, Y. and Verwey, W. F., *Bull. Wld. Hlth. Org.*, 1965. **32**, 809.
23. Bhaskaran, K. and Sinha, V. B, *J. Hyg. Camb.*, 1967, **65**, 135.

THE S-TECTONITE FABRIC AS A MEANS OF INTERPRETING THE SLIP MOVEMENT AND FOLDED STRUCTURE

K. V. SURYANARAYANA
Department of Geology, Sri Venkateswara University, Tirupati

ABSTRACT

A crushed quartzite and two other quartzites taken from a bedded series of Satnur area, Bangalore District, were examined for their microfabric features. All the three samples exhibit an S-tectonite fabric with the maximum at *a* fabric axis. It is concluded that one single type of movement, either due to faulting or to slipping along bedding planes, would produce an S-tectonite fabric with a single maximum and without a girdle.

INTRODUCTION

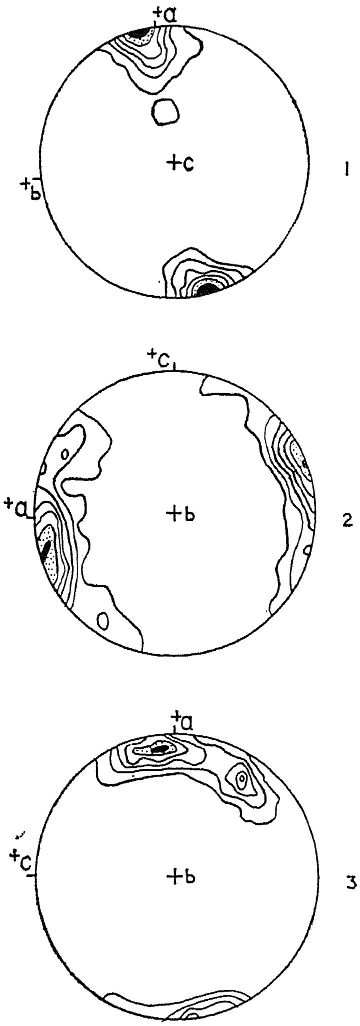
One of the outstanding contributions of Sander[1] to the petrofabric analyses of rocks is his finding that the mylonites and slickensided rocks conform to a typical S-tectonic fabric. This fabric is characterised by lineation that coincides with the direction of movement, *i.e.*, with the *a* axis of the fabric. His other findings on the fabric of slickensided rocks are: (*i*) the strong tendency of quartz grains to lie with the optic axes parallel to *a* axis, and (*ii*) the elongation of the quartz grains also parallel to *a*.

QUARTZITES OF THE SATNUR AREA

Ever since Sander's announcement of the characteristic features of slickensided rocks, reports of such occurrences have been scanty. The present author examined a crushed quartzite selected from along a fault zone about four miles south-east of Satnur, Bangalore District. Slickensides are not found, but the rock has the features of a mylonite, because of its fine-grained nature due to crushing and the presence of closely-spaced slip planes. The slip planes render the rock schistose. An oriented section of this quartzite was taken parallel to the slip plane which is the *ab* plane. The quartzite is fine-grained, equigranular; but the grains are slightly inequidimensional, ellipsoidal, with length measuring 0·23 mm and breadth 0·14 mm. The longer axes of the grains are parallel to *a* fabric axis. Majority of the grains become extinct when the lengths of these grains are parallel to either of the cross hairs. This strong preferred orientation of the fabric elements is also revealed when their compensation behaviour is tested with the gypsum plate. As the stage is rotated, at one position the whole field shows first order red indicating that the majority of the grains are in extinction position. A slight rotation of the stage from this position, clockwise or anti-clockwise, will change the colour of the field to first order yellow or to second order yellowish-green. This is a further indication of the parallelism of the optic axis [0001] of quartz grains.

Figure 1 is the orientation diagram of the quartzite taken from the fault zone. It is prepared by plotting 215 quartz axes. The preferred orientation is of a high degree representing concentration of 26% in 1% area (contours are drawn at intervals of 5%). The diagram bears a remarkable similarity to the slickensided mylonite-granite reported by Sander from Melibokus, Odenwald, (Knopf and Ingerson[2]). The maximum lies at the *a* fabric axis indicating that the quartz axes in a majority of the grains lie parallel to *a* axis of the fabric in the *ab* plane, typical of an S-tectonite. This corresponds to the point maximum I of the maxima numbered I to VIII by Sander (Fairbairn[3]). The direction of displacement parallel to *a* is evident. This is also confirmed by the slight elongation of the quartz grains and the undulose bands parallel to *a*. The quartz axis is, therefore, parallel to lineation. The one maximum at *a* represents a very simple type of fabric originating under the predominant influence of one single type of movement. The displacement is penetrative along the *ab* plane, parallel to the trend of the quartz axes and to lineation. It is to be noted that, as in Melibokus granite, the quartz axes are slightly dispersed in the *ac* plane forming the beginnings of an *ac* girdle parallel to the direction of movement.

The author has found that the maximum I at *a* furnishes a means of establishing the movement not only along the slickensided surfaces but also along the bedding planes in the folded and metamorphosed terrains, where evidences of folding are otherwise absent. Two such cases of movement along bedding planes are here presented.



Figs. 1–3

An oriented specimen of quartzite was taken from a folded series of rocks near the same locality, but about two miles from the fault zone. The fold is a pitching syncline, and the rocks folded are quartzite, hornblende schist, charnockite, and calc-granulite (Suryanarayana[4]). The quartzite can be traced from limb to limb around the fold axis. The bedding plane is taken as the *ab* plane, *b* parallel to the strike. The section was taken perpendicular to *b*. The quartzite is coarse-grained; the grains are large, with a high length/breadth ratio, the length being parallel to the *a* fabric axis. The undulose bands are also parallel to the length. The lineation is therefore down dip, parallel to *a*. Figure 2 represents the orientation diagram of 300 quartz axes of this quartzite. The maximum represents a concentration of points upto 13% in 1% area, the contours having been drawn at intervals of 2%. The near parallelism of the quartz axes to the fabric axis *a* is evident as in Fig. 1. This suggests that the S-tectonite fabric with the maximum I in *a* is also produced by the slipping or movement of rock bodies along the bedding plane during the process of folding. The specimen is taken from the middle of the quartzite band, so the movement has affected the grains throughout the main body. It is to be noted that the maximum and the contours are spread along *ac* plane, indicating the dispersal of the quartz axes in the *ac* plane and a tendency for a girdle development. The incomplete girdle along the *ac* plane shows the transition towards a B-tectonite. The spread of contours towards a girdle pattern suggests a bending or rotational movement along *ac* plane around *b* axis, as often happens when a rock is undergoing folding.

A specimen from another quartzite band away from the folded series was selected. There is no evidence of this quartzite forming part of the folded series, but it dips at a high angle. As in the previous example, the section was taken perpendicular to *b*, the direction of strike. The grains are large, inequidimensional; and the ratio of length to breadth is very high. The lineation is down dip, parallel to *a*. Figure 3 is the orientation diagram of 300 quartz axes. Here also the maximum is of a high degree with 20% pole concentration in 1% area (contours are drawn at intervals of 4%). This bears similarity both to Fig. 1 and Fig. 2. The girdle is poor but shows tendency for development along *ac* plane. Movement by slipping along single S-plane, *i.e.*, the bedding plane, rather than the bending movement, is dominant.

CONCLUSION

The similarity of the fabric pattern between the crushed quartzite and the other two that form part of the bedded series suggests that the sedimentary metamorphosed sequences in the Closepet-Satnur area of Bangalore District have undergone slipping movement along the bedding planes, whether they have been folded or not, during the regional deformation of the rocks of this area. The lack of girdle development in Fig. 3 points to the fact that the quartzite which this diagram represents forms, in all likelihood, the middle part of a limb of a regional fold.

ACKNOWLEDGEMENT

The author expresses his thanks to Dr. M. G. Chakrapani Naidu, Professor of Geology, Sri Venkateswara University College, for the encouragement offered in the course of the work.

1. Sander, Bruno, *Gefuge kunde der Gesteine*, Julius Springer, Vienna, 1930.
2. Knopf, E. B. and Ingerson, E., "Structural petrology," *Mem. Geol. Soc. America*, 1938, **6**, 140
3. Fairbairn, H. W., *Structural Petrology of Deformed Rocks*, Addison-Wesley Publishing Co., Inc., Cambridge 42, Mass., 1949, p. 117.
4. Survanarayana, K. V., "The Closepet granite and associated rocks," *The Indian Mineralogist* 1960, **1**, 86.

MUTATIONAL ANALYSIS OF A LOCUS GOVERNING BRITTLENESS IN *ORYZA SATIVA*

C. B. SINGH
Atomic Energy Laboratory, I.A.R.I., New Delhi-12

STUDIES on complex loci have given much insight into the functional, mutational and recombinational aspects of the gene. More than forty years ago, Dubinin, Seribrovsky and others suggested that "achaete scute" alleles in *Drosophila* can be arranged in a definite series. This view was later developed and subsequently it was concluded that this locus comprised separate, regularly-spaced and lineally-arranged functional units.[1] Seven years later, another complex locus called "lozenge" was discovered[2] and based on interallelic or intragenic recombination, the theory of "pseudo-allelism" was put forth.[3] More recently, using both recombinational and mutational analyses, the genetic fine structure has been investigated in a considerable detail at several gene loci in a variety of organisms. The work with micro-organism in general and *Neurospora* in particular has changed our earlier concept of gene structure. However, the final break-through that gave the first indisputable evidence of complexity of genes was obtained in research with bacteriophages[4] and bacteria.[5] These studies indicated that genes are complex in nature, in which changes could occur at different sites, giving rise to different alleles.

Unlike in *Drosophila* and micro-organisms, the resolving power of genetic analysis is low in higher organisms due to limitations in handling a large population, thereby reducing the chances of recovering rare recombinants. During the present study, several mutants characterized either by fragile culms, leaves or both were isolated from the M_2 generation of non-brittle *japonica* variety, of rice (*Oryza sativa* L.), Tainan-3, which had been treated with physical (gamma-rays) as well as chemical (ethylmethane sulphonate, nitroso methyl urea) mutagens. The complete brittle mutant had brittle rachis in addition to brittle culm and leaves. Mutants with brittle rachis alone were not observed. The frequency of occurrence of each type is presented in Table I.

TABLE I

Frequency of different type of brittle mutations

Product of mutation	Mechanism	Frequency (Mutants in No. of M_2 plants)
1. Complete Brittle ..	$s \longrightarrow S$	1/50,000
2. Brittle culm ..	$BC \longrightarrow bc$	7/50,000
3. Brittle leaf ..	$BL \longrightarrow bl$	10/50,000
4. Brittle rachis ..	$BR \longrightarrow br$	Not studied

As far as the genetics of brittle character is concerned, the earlier reports suggest that brittle culm is controlled by a single recessive gene, bcc.[6,7] Jodon[8] reported that the fragile nature develops more in older seedlings, while Siddiq[9] obtained a completely brittle mutant in the M_2 generation of Taichung-65 where he observed a brittle tendency even at the young stage of seedlings.

From the present findings, it appears that the genetic control of brittle character is complex. Based on a study of the different types of induced mutations and their frequency the brittle locus has probably three different mutational sites, BC, BL and BR (for culm, leaves and rachis respectively) and in addition there is a suppressor gene, S. Non-brittle rice varieties may, therefore, have the genotype, BC BL BR / BC BL BR and an inactive suppressor gene *s*. Rare mutations at the inactive suppressor locus *s* result in active suppressor gene S which gives rise to a complete brittle plant. Mutations involving different sites occur independently of each other resulting in brittle culm, brittle leaves or brittle rachis more frequently. The order and size of these sites are still unknown due to lack of recombinational analyses. However, a hypothetical model is presented in Fig. 1.

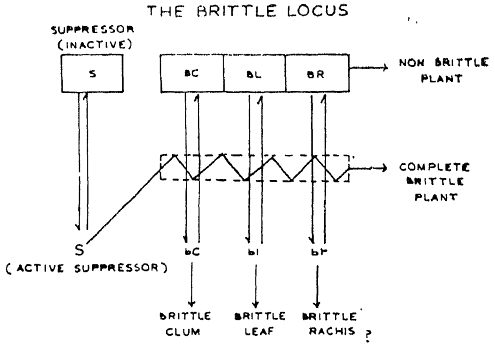


Fig. 1

The chemical nature of the fragile character has not been worked out. The only report in this context is by Takahasi[10] which indicates that the brittle character develops due to a reduction in the α-cellulose content. Mutations at the brittle locus might alter the α-cellulose content of total carbohydrate present in the cell-walls in similar ways, as the *indica* and *japonica* grain mutations have been found to change the amylose/amylopectin fractions of starch content in rice.[11,12] The suppressor gene mechanism involved in this system might disturb the normal functioning of brittle genes through its end product interaction. Further studies are, however, necessary on interallelic complementation in order to test the validity of the present hypothesis.

ACKNOWLEDGEMENTS

Author is highly indebted to Dr. M. S. Swaminathan for his valuable guidance throughout the tenure of this study and for going through the manuscript. Financial assistance of I.C.A.R. is gratefully acknowledged.

---

1. Dubinin, N. P., *J. Genet.*, **1932, 26,** 37.
2. Oliver, C. P., *Proc. Nat. Acad. Sci*.. US, **1940, 26,** 452.
3. Lewis, E. B., *Cold Spring Harbor Symp. Quan. Biol.*, **1951, 16,** 159.
4. Benzer, S., *Proc. Nat. Acad. Sci.*, U.S., **1955, 41,** 344.
5. Demerec, M., *Am. Naturalist*. **1955, 89,** 5.
6. Jones, J. W., *J. Agr. Res.*, U.S., **1933, 47.** 771.
7. Seetaraman, R., *Curr. Sci.*, **1965, 24** (6), 189.
8. Siddiq, E. A., *Ph.D. Thesis.*, I.A.R.I., **1967.**
9. Jodon N. E.. *Plant Ind. Sta.* (U.S.), *Dept. Agr.*, **1948, 112 CC,** 1 (Mimeo).
10. Takahasi, M. E., *Symp. Rice Genet. Cytogenet.*, I.A.R.I., **1963,** Elsevier, **1964,** p. 215.
11. Siddiq, E. A. and Swaminathan, M. S., *Mutation Res.*, **1968, 6,** 478.
12. Singh, C. B., *Ph.D. Thesis*, I.A.R.I., **1970,**

LETTERS TO THE EDITOR

A SIMPLE MAGNETIC UNIVERSE

We shall call a distribution of magnetic field together with its associated geometry 'a magnetic universe'. One such universe is discussed by Melvin[1,2] and Melvin and Wallingford.[3] The object of the present note is to report on a simple magnetic universe which is different from that of Melvin.

The geometry of this universe is described by the line element

$$ds^2 = (dx^0)^2 - (dx^1)^2 - Y^2 (dx^2)^2 - (dx^3)^2, \quad (1)$$

where Y is function of x^1 alone. The metric (1) admits a 3-parameter group of motions, for it is unchanged by the transformation

$$\bar{x}^0 = x^0 + B_0,\ \bar{x}^2 = x^2 + B_2,\ \bar{x}^3 = x^3 + B_3 \quad (2)$$

where the B's are arbitrary constants.

The non-vanishing components of Ricci tensor $R_k{}^i$ for the metric (1) are given by

$$R_1{}^1 = R_2{}^2 = -\frac{Y_{11}}{Y}. \quad (3)$$

The subscripts denote the differentiation with respect to x^1.

Now, for a magnetic field

$$R = 4\lambda \quad (4)$$

where R is the curvature scalar and λ is the cosmological constant. The equations (3) and (4) imply that

$$Y_{11} + 2\lambda Y = 0. \quad (5)$$

The solution of the above equation is given by

$$Y = B \cos(\sqrt{2\lambda}x^1 + C) \quad (6)$$

where B and C are constants of integration.

Applying a transformation similar to (2), one can make $B = 1$ and $C = 0$. Therefore, finally we have

$$Y = \cos(\sqrt{2\lambda}x^1). \quad (7)$$

The magnetic field in the universe can be described by a 4-potential ϕ_i of the form

$$\phi_i = \{0, 0, f(x^1), 0\} \quad (8)$$

so that only one component of the electromagnetic field tensor F_{ik}, *viz.*, F_{12} is non-vanishing.

$$F_{12} = -f_1. \quad (9)$$

The absence of charge and currents in the field implies that

$$F^{12} = \frac{A}{Y} \quad (10)$$

where A is a constant of integration. Results (9) and (10) lead to $f_1 = -AY$ so that

$$F_{12} = AY \quad (11)$$

where Y is given by (7).

The field equations of Einstein-Maxwell theory with a non-vanishing cosmological constant λ are

$$R_k{}^i - \lambda\delta_k{}^i = \tfrac{1}{2}(F^{in}F_{kn} - \tfrac{1}{4}\delta_k{}^i F_{mn}F^{mn}).$$

These equations are satisfied if we take λ to be positive and

$$\lambda = A^2. \quad (12)$$

Consider now a local observer using a Minkowskian frame of reference in his neighbourhood. The electromagnetic field as observed by him can be visualized by choosing the following tetrad at a point.

$$\gamma_{(a)}{}^i = \text{diag}\{1, 1, \cos(\sqrt{2\lambda}x^1), 1\} \quad (13)$$

Using (13) we find that the only non-vanishing tetrad component of F_{ik} is given by

$$F_{(12)} = H_3 = A = \sqrt{\lambda} \quad (14)$$

This shows that the local observer observes a magnetic field in the direction of $r^i{}_{(3)}$.

Here it should be noted that in Melvin's universe $\lambda = 0$, while in our solution λ plays a central role. If we set $\lambda = 0$, the electromagnetic field is also switched off and the geometry becomes Minkowskian. This is an interesting feature of our solution.

Dept. of Mathematics, L. K. Patel.
Gujarat University, P. C. Vaidya.
Ahmedabad 9, *March* 6, 1971.

---

1. Melvin, M. A., *Phys. Letters*, 1964, **8**, **65**.
2. —, *Phys. Rev.*, **1965**, **139**, **225**.
3. —. and Wallingford, J. S., *J. Math. Phys.*, **1966**, **7**, **333**.

ROTATORY DISPERSION OF SODIUM PERIODATE AND GUANIDINE CARBONATE

There has been a considerable revival of interest in the study of crystalline optical activity since the quadratic type of rotatory dispersion formula was first introduced by Chandrasekhar[1,2] and applied successfully to α-quartz, cinnabar, sodium chlorate and benzil crystals. On the theoretical side, Agranovich[3] developed a quantum mechanical theory of crystalline optical activity and showed that it leads to the same formula derived by Chandrasekhar on the basis of an elementary model. On the experimental side the formula has been found to explain the rotatory dispersion, its temperature and pressure variation, of a number of crystals.[4–13] In this communication, the applicability of the formula to two more cases, *viz.*, sodium periodate ($NaIO_4.3\,H_2O$; belonging to the space group $C_3{}^4$) and guanidine carbonate [$(CN_3H_5)_2.H_2CO_3$; belonging to the space group $D_4{}^4$ $(D_4{}^8)$] is discussed. Previous data on these crystals are scanty[14,15] and no attempts have been made to express the data in terms of any formulae.

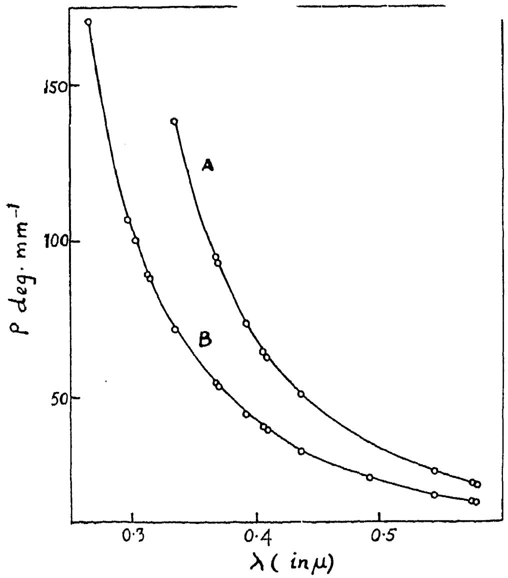


FIG. 1. Rotatory dispersion of (A) Sodium periodate; (B) Guanidine carbonate.

The crystals were grown from solution at room temperature by the slow evaporation technique and cut with faces perpendicular to the optic axis. The faces were ground and polished, and their parallelism was tested optically. The crystals were sandwiched between two fused silica discs with a drop of paraffin. The spectropolarimeter arrangement was the same as described in an earlier paper.[7]

Measurements on sodium periodate were made for 10 wavelengths from λ 0·5790 μ to λ 0·33415 μ and could not be extended to shorter wavelengths because of high absorption; measurements on guanidine carbonate were made for 16 wavelengths from λ 0·5790 μ to λ 0·2652 μ. The rotatory power of both crystals are expressible by a single term Chandrasekhar formula

$$\rho = \frac{K\lambda^2}{(\lambda^2 - \lambda_0{}^2)^2}$$

with the following constants:

	K	λ_0
Sodium periodate	5·641	0·21
Guanidine carbonate	4·637	0·1625

The rotatory dispersion curves are presented in Fig. 1 and as can be seen the agreement is satisfactory. For $NaIO_4.3\,H_2O$ the r.m.s. deviation between calculated and experimental rotatory power is 0·41 deg/mm and the maximum deviation 1·7%; for guanidine carbonate the corresponding values are 0·51 deg/mm and 1·5%.

Dept. of Physics, M. S. MADHAVA.
University of Mysore,
Mysore, *March* 19, 1971.

---

1. Chandrasekhar, S., *Proc. Ind. Acad. Sci.*, 1952, **35 A**, 103.
2. —., *Proc. Roy. Soc.*, 1960, **259 A**, 531.
3. Agranovich, V. M., *Optika i Spectrosk* (*USSR*), 1957, **2**, 738.
4. Vysin, V., *Vest. Mosk Gos. Univ.*, 1963, **3**, 6.
5. Kizel, V. A., Krasilov Yu. I. and Shamraev, V. N., *Optics and Spectrosk.* (*USSR*), 1964, **17**, 470.
6. Belajev, L. M, and Perekalina, Z. B., *Sov. Phys. Cryst.* (*USA*), 1967, **12**, 243.
7. Chandrasekhar, S. and Madhava, M. S., *Acta Cryst.*, 1967, **23**, 911.
8. Myers, M. B. and Vedam, K., *J. Opt. Soc. Am.*, 1965, **55**, 1180: 1966, **56**, 1741; 1967, **57**, 1146.
9. Vedam, K. and Davis, T. A., *J. Opt. Soc. Am.*, 1968, **58**, 1451.
10. Perekalina, Z. B., Shchelokov, R. N. and Burkov, V. I. *Sov. Phy.-Cryst.*, 1969, **14**, 270.
11. Belyaev, L. M., Perekalina, Z. B. and Klimova, A. Yu., *Sov. Phys.-Cryst.*, 1970, **15**, 501.
12. Madhava, M. S., *Proc. Ind. Acad. Sci.*, 1970, **72**, 67.
13. Perekalina, Z. B. and Smirnova, N. I., *Sov. Phys.-Cryst.*, 1970, **14**, 708.
14. Groth, *Ann. der Physik*, 1869, **137**, 433.
15. Bodewig, *Ibid.*, 1876, **157**, 122.

EXPERIMENTAL MEASUREMENT OF THE K-CONVERSION COEFFICIENT OF 80 keV TRANSITION IN 144 Pr

THE K-conversion coefficient of the 80 keV transition has been determined using a 2·5 cc Ge (Li) detector for the gamma intensity measurements. Several groups have reported conflicting results for the K-conversion coefficient of this line. Hicock *et al.*[1] combining their X-ray and γ-ray intensity measurements with scintillation spectrometers and the internal conversion line measurements with magnetic lens beta spectrometer found for the 133 and 80 keV transitions—α_K values $0 \cdot 76 \pm 0 \cdot 15$ and $1 \cdot 40 \pm 0 \cdot 24$ respectively. As the transitions involved are pure M_1 in character, these values differ from the theoretical conversion coefficients for such transitions. Zuk and Gustaffsson[2] combining their gamma singles measurements with a scintillation spectrometer and internal conversion line intensities of Geiger *et al.*[3] found for the 80 keV transition an α_K value of $1 \cdot 3 \pm 0 \cdot 2$. Iwashita *et al.*[4] from the gamma-gamma coincidence measurements found a value of $\alpha_K = 2 \cdot 0 \pm 0 \cdot 4$ for the 80 keV transition with respect to an α_K value of $5 \cdot 6$ for the 53 keV transition. Mangal and Trehan[5] found for the same transition α_K value of $2 \cdot 8 \pm 0 \cdot 6$ relative to $9 \cdot 4 \pm 1 \cdot 0$ for the 53 keV transition from the coincidence spectrum gated with the 35 keV Pr-X rays. Geiger *et al.*[6] found quite conflicting results for the K-conversion coefficient of the 53 keV transition from different measurements.

Thus the results are far from satisfactory and necessitate redetermination of these conversion coefficients. We have measured the gamma intensity of the 80 keV transition relative to the intensity of the 133 keV transition with a 2·5 cc Ge (Li) detector. The K line electron intensities for these transitions have been taken from the paper by Geiger *et al.*[3] Combining the electron and gamma intensities and taking $\alpha_K\,(133) = 0 \cdot 495$,[7] and using the following relation:

$$\alpha_K\,(80) = \alpha_K\,(133)\,\frac{I_\gamma\,(133)}{I_K\,(133)}\,\frac{I_K\,(80)}{I_\gamma\,(80)} \qquad (1)$$

we obtain for the 80 keV transition $\alpha_K = 2 \cdot 09 \pm 0 \cdot 16$ which agrees well with the theoretical conversion coefficient 2·1.[7] We conclude that the conversion coefficient is quite normal and is explained without involving any penetration effects as suggested by Mangal and Trehan.[5]

The author is grateful to Docent J. E. Thun and his group for research facilities and hospitality during his stay in Uppsala where this work was done.

Physics Department,
Punjabi University,
Patiala, *February* 15, 1971.

H. S. SAHOTA.

---

1. Hickock, R. L., Mckinley, W. A. and Fultz, S. C., *Phys. Rev.*, 1958, **109**, 113.
2. Zuk, W. and Gustafsson, S., *Arkiv for Fysik*, 1963, **24**, 69.
3. Geiger, J. S., Graham, R. L. and Ewans, G. T., *Nucl. Phys.*, 1960, **16**, 1.
4. Iwashita, T., Inasura, T. and Ihemota, Y., *J. Phy. Soc. Jap.*, 1963, **18**, 1358.
5. Mangal, P. C. and Trehan, P. N., *Ibid.*, 1969, **27**, 1.
6. Geiger, J. S., Graham, R. L. and Ewans, G. T., *Nucl. Phys.*, 1961, **28**, 387.
7. Hager, R. S. and Saltzer, E. C., *Internal Conversion Tables AEC Research and Development Report CALT-63-60.*

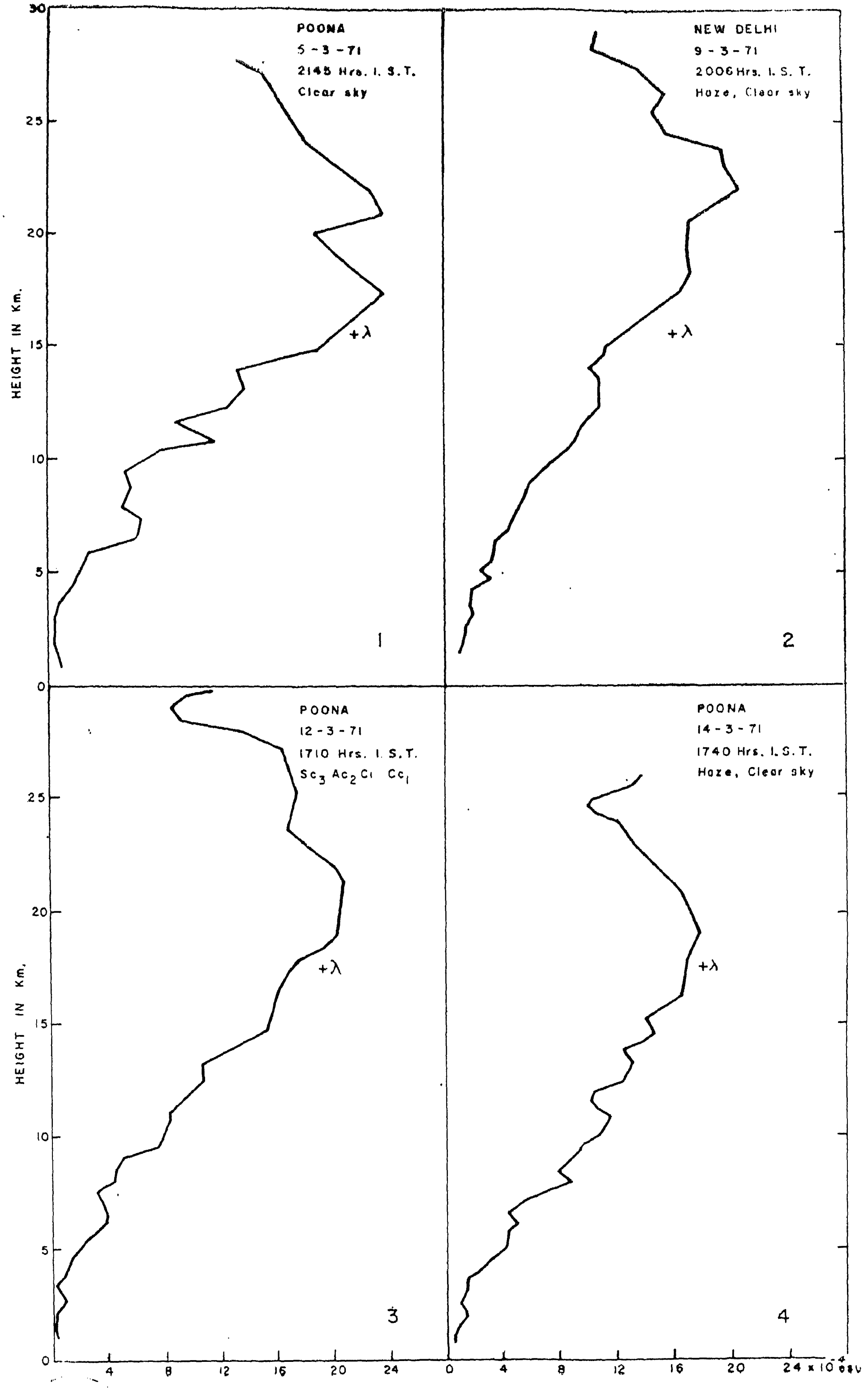
INTERESTING EVIDENCE OF STRATOSPHERIC DUST FROM ELECTRICAL CONDUCTIVITY MEASUREMENTS

SINCE 1958, a number of measurements have been made to study the nature and properties of aerosol layers in the stratosphere. Particle samples have been taken by aircraft and balloon-borne collecting devices and indirect measurements of stratospheric dust have been made using optical techniques, such as twilight sky intensity measurements, searchlight probing, laser probing, stratospheric daytime sky brightness measurements and solar extinction measurements made from rockets, satellites and balloons (Rosen, 1969).

Kroening (1960) used a different technique, *viz.*, small ion density measurements to detect the presence of stratospheric dust. He found a large decrease from about 4×10^3 ions per cm^3 to 2×10^3 ions per cm^3 above 18 km. Similar decreases in the small ion concentration had been earlier observed by Gish and Sherman (1936) and later by Paltridge (1965, 1966).

The electrical conductivity in the stratosphere should also be affected by the presence of dust, since the conductivity is proportional to the small ion concentration. Gish and Sherman (1936) found a considerable drop in conductivity above 18 km, but this was attributed to the ozone layer and the presence of condensation nuclei at these levels. McDonald (1953) pointed out that this observed decrease in conductivity with height is supported by some earlier measurements by Idrac (1928) and urged that these be repeated using more modern sounding techniques. Stergis *et al.* (1955), Woessner *et al.* (1958) and Bourdeau *et al.* (1959) did not, however, observe any decrease in the conductivity at high altitudes that could be attributed to the effect of dust. Paltridge's (1965) measurements were made soon after the 1963 Bali eruption.

Figures 1, 3 and 4 show the vertical profiles of electrical conductivity obtained over Poona on 5, 12 and 14 March 1971, and Fig. 2 over


POONA
5-3-71
2145 Hrs. I. S.T.
Clear sky
NEW DELHI
9-3-71
2006 Hrs. I. S. T.
Haze, Clear sky
POONA
12-3-71
1710 Hrs. I. S.T.
Sc3 Ac2 Ci Cc1
POONA
14-3-71
1740 Hrs. I.S.T.
Haze, Clear sky
+λ
1
2
3
4
HEIGHT IN Km.
0
5
10
15
20
25
30
4
8
12
16
20
24
24 x 10⁻⁴ esu

FIGS. 1-4

Delhi on 9 March 1971. The electrical conductivity increases with height as expected till about 18 km, when it falls sharply to about half its value, with the profile showing a series of marked minima. Above 25-28 km, the conductivity again shows a sharp increase with height. Sharp variations had been noticed in the electrical potential gradient profile in the lower stratosphere over Poona (Huddar *et al.*, 1966). These marked variations in electrical conductivity and potential gradient are presumably associated with the existence of dust layers in the lower stratosphere over India. The observed values are much lower than the theoretical values (Israel, 1970). The observations are being continued and extended using an improved conductivity sonde.

India Meteorological Dept., A. MANI.
New Delhi-3, India, B. B. HUDDAR.
Poona-5, India, G. P. SRIVASTAVA.
April 27, 1971.

1. Bourdeau, R. E., Whipple, E. C. and Clark, J. F., *J. Geophys. Res.*, 1959, **64**, 1363.
2. Gish, O. H. and Sherman, K. L, *Nat'l Geograph. Soc. Stratosphere*, Ser. No 2, Washington, p. 94.
3. Huddar, B. B., Srivastava, G. P. and Mani, A., *Proc. IQSY Symposism*, New Delhi, 1966, p. 634.
4. Idrac, P,, *C. R. Acad. Sci.*, 1928, **182**, 1634.
5. Israel, H., *Atmospheric Electricity*, Israel Program for Scientific Translations, Jerusalem, 1970, **1**, 110.
6. Kroening, J. L., *J. Geophys. Res.* 1960, **65**, 145.
7. McDonald, J. E., *Trans. Am. Geophys.*. 1953, Un. **34**, 523.
8. Paltridge, G. W., *J. Geophys. Res.*, 1965, **70**, 2751.
9. —, *Ibid.*, 1966, **71**, 1945.
10. Rosen, J. M., *Space Science Review*, 1969, **9**, 58.
11. Stergis, C. C., Gornoiti, S. C., Nazarek, A., Kotas, D. E., Ssymour, D. W. and Werme, J. V., *J. Atmospheric Terr. Phys.* 1955, **7**, 233.
12. Woessner, R. H., Cobb, W. E. and Gunn, R., *J. Geophys. Res.*, 1958, **68**, 4929.

SILVER-SILVER SELENOCYANATE ELECTRODE

SILVER halide electrodes are most commonly used as reference electrodes. The details of their preparation and use are well known.[1] Silver thiocyanate electrodes have been prepared by Parida *et al.*[2] and improved upon by Vanderzee and Smith.[3] We have extensively used this electrode for study of $SeCN^-$ equilibria in solution.[4,5] In continuation of this work we have developed silver selenocyanate electrode to study $SeCN^-$ equilibria. It is found that the thermal-electrolytic method gives the most satisfactory result in terms of reproducibility, stability and convenience of preparation.

Preparation of the Electrode.—Platinum spirals, each 1 cm long, sealed in soft glass were packed with paste of silver oxalate prepared by the method of Ferrell *et al.*[6] They were then dried in an oven for several hours at 160-80° C and then heated in a furnace at 400° C for an hour and allowed to cool slowly. The preliminary drying period prevents sputtering during the decomposition period. Decomposition of silver oxide to spongy silver also gives satisfactory result but it is not preferable to decomposition of silver oxalate because of the tedious process of washing the oxide free from alkali after its preparation by the reaction of silver nitrate with sodium hydroxide. The silver bases were electrolysed as anodes in 0·05 M selenocyanate solution for 3 hours at 0·2 to 0·4 milliampere. Following several washings with water, they were allowed to equilibrate in a portion of cell solution for at least three days before use. These electrodes were prepared in groups of six to eight and always kept dipped in a solution of potassium selenocyanate.

Results.—It was observed that electrodes prepared in this method are reversible with respect to $SeCN^-$ ion and can comfortably be used to estimate the ion potentiometrically. Figure 1 shows a typical potentiometric titration curve and Table I gives the results of different titration curves. Presence of an in-

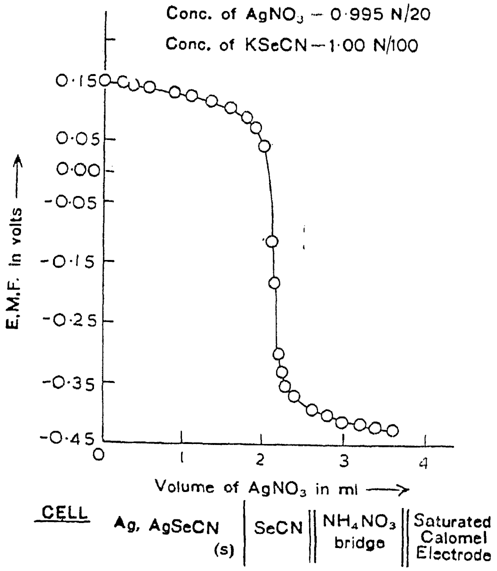


FIG. 1

different electrolyte does not affect the estimation result.

TABLE I

Sl. No.	Amount of KSeCN taken	Amount of KSeCN found	Amount of indifferent electrolyte added
1	14·50 mg	14·69 mg	..
2	29·0 ,,	29·8 ,,	..
3	14·50 ,,	41·69 ,,	6·0 mg of NaCl
4	14·50 ,,	14·83 ,,	50 mg of KNO_3

It was, however, observed that, although electrodes prepared in one set in which electrolysis is done at a particular current strength and for a particular length of time usually matched within 0·3 mv but when compared with those of another set prepared at different conditions of electrolysis, the difference reached as much as 1 mv. However, electrodes prepared in different batches but electrolysed under similar conditions matched within 0·3 mv. Thus, silver selenocyanate electrode can conveniently be used for studying the behaviour of $SeCN^-$ in aqueous solution.

Dept. of Chemistry,
Ravenshaw College,
Cuttack,
January 22, 1971.

K. C. BADU.
D. SATYANARAYANA.
G. SAHU.
R. C. DAS.

---

1. Janz, G. J., *Reference Electrodes*, Edited by Ives, D. J. G. and Janz, G. J., Academic Press Publication, 1961, p. 179.
2. Parida, R. N., Aditya, S. and Prasad, B., *J. Indian Chem. Soc.*, 1952, **29**, 377.
3. Vanderzee, C. E. and Smith, W. E., *J. Amer. Chem. Soc.*, 1956, **78**, 721.
4. Das, R. C., Dash, A. C. and Mishra, J. P., *J. Inorg. Nucl. Chem.*, 1968, **30**, 2417.
5. —, —. Satyanarayana, D, and Dash, U. N., *Thermochimica Acta* (Communicated), 1970.
6. Ferrell, D. T., Blackburn, I. and Vosburgh, W. C., *J. Amer. Chem. Soc.*, 1948, **70**, 3812.

β-CAROTENE IN LEAF PROTEINS*

THE fibre-free leaf protein extracted from green vegetations has been successfully presented as an adequate protein supplement in human diets.[1] The crude green product is assumed to contain nutritionally important pigments like carotenes and xanthophylls and solvent extraction is therefore considered inadvisable. Estimations for β-carotene were, therefore, done on different leaf proteins to provide experimental support to this assumption.

However, when some of the old dry samples of leaf proteins were soxhlet-extracted, no traces of β-carotene were observed in those from cauliflower (9 months), lucerne (12 months) and dhaincha (14 months), and only 90 and 55 μg of β-carotene/g dry matter in preparations from lucerne (18 days old) and groundnut (12 days old) respectively. This indicated loss in β-carotene during storage.

To standardise the methodology, β-carotene levels were estimated in a number of freshly prepared lucerne leaf protein samples, both in wet materials extracted in soxhlet on a boiling water-bath or in cold and in materials soon after drying in a current of air at 40-60° C. Hot soxhlet extraction was found to give 30% lower values than cold extraction and air-drying caused a loss of 13% in β-carotene of the fresh wet material.

Thereafter, total carotenoid pigments in different leaf proteins were extracted with acetone and taken up in petroleum ether (b.p. 60-80° C) and β-carotene separated on MgO : Supercel (1 : 3) column[2] and estimated colorimetrically, using a Spectronic-20 photoelectric colorimeter.[3] The results are presented in Table I along with computed values for vitamin A. These β-carotene values were lower than those got elsewhere,[4] probably because of the losses during the inefficient batch-extraction,[5] the process used by us for preparing leaf protein. However, it is apparent from the data that green leaf protein even in very small quantities would adequately meet the pro-vitamin A requirements, particularly in India where a quarter of the total nutritional deficiencies are reported to be due to shortage of vitamin A in diets.[6]

TABLE I
β-carotene in leaf proteins

Leaf protein from*		β-carotene (μg)	Vitamin A† (IU)
		(per g dry matter)	
Dolichos lablab	..	960	1603
Tapioca (*Manihot utilissima*)		365	610
Lucerne (*Medicago sativa*)‡	..	380–450	635–750
Carrot (*Daucus carota*)	..	495	826
Radish (*Raphanus sativus*)	..	503	840

* Only fresh wet material used for extraction.

† Conversion factor—β-carotene 1 μg = 1·67 I.U. of vitamin A.

‡ Range of 3 samples from different batches of vegetation.

In storage studies, a progressive loss occurred with time, greater at room temperature than at low temperature of the refrigerator. Further studies showed practically no losses of β-carotene when leaf protein samples were stored for over 6 weeks in the freezer compartment. This technique of preservation was later used in nutritional evaluation of leaf protein as a source of β-carotene in rat diets.[7] The use of freshly prepared material, wet or that soon after drying, is the obvious choice because of losses during storage. However, the problems of conserving β-carotene in leaf proteins during ordinary storage still need to be solved.

Central Food Tech. Research Institute,
Mysore, *January* 29, 1971.

K. V. R. Ramana.
Narendra Singh.

---

* Preliminary communication at 13th Annual General Meeting of the Society of Biological Chemists (India), December 1969, Bombay.

1. Doraiswamy, T. R., Singh, N. and Daniel, V. A., *Brit. J. Nutr.*, 1969, **23**, 737.
2. *Methods of Vitamin Assay*, The Association of Vitamin Chemists, 2nd Ed., Int. Sci. Pub. Inc., New York, 1951, p. 45.
3. Zecheister, L. and Polgar, A., *J. Amer. Chem. Soc.*, 1943, **65**, 1522.
4. Pirie, N. W., Personnal communication, Rothamsted Experimental Station, Harpenden.
5. Davys, M. N. G. and Pirie, N. W., *J. Agric. Engng. Res.*, 1963, **6**, 71.
6. *The Nutritive Value of Indian Foods and Planning of Satisfactory Diets.* 6th revised edition. Gopalan. C. and Balasubramanian, S. C., New Delhi, ICMR, 1966, p. 11.
7. Ramana, K. V. R. and Singh, N., *Ind. J. Exptl, Biol.*, 1971 (Communicated).

ARREST OF CHLOROPHYLL AND PROTEIN BREAKDOWN IN SENESCING LEAF DISCS OF KALE BY CYCLOHEXIMIDE AND VANILLIN

Some inhibitors of RNA and protein synthesis inhibit yellowing in *Brassica* and *Zea* leaves kept in darkness.[1–3] The results suggest that yellowing is dependent either on synthesis of some specific proteins or/and on the rate of protein breakdown.

7-mm discs were punched from mature leaves of kale, *Brassica oleracea* L. var. *acephala cv.* "niski zielony kedzierzawy", floated on distilled water or solutions of cycloheximide, vanillin or abscisic acid (ABA), and kept in darkness for 1, 2 or 4 days at 25°. In tests on protein or RNA synthesis the discs pretreated for 24 hr with the inhibitors were washed and transferred to 1·8 ml of L-leucine-U-^{14}C (1 μCi/ml; specific activity 90 mCi/mM) or uracil-2-^{14}C (5 μCi/ml; specific activity 6 mCi/mM) and fed in light (1400 lx) at 23°. To determine the effects of the compounds in protein breakdown, freshly punched discs were fed with labelled leucine for 3 hours, washed, and transferred to solutions of the compounds to be tested supplemented with L-leucine-^{12}C (10^{-3} M) and kept in darkness for 2 days, the solutions being renewed after 24 hr. All incubation media were supplemented with penicillin G 50 mg/l. Protein and RNA were extracted and estimated according to references 4 and 5, and 6 respectively. Chlorophyll was extracted with 80% acetone and measured spectrophotometrically.[7] Radioactivity was counted with approximately 35% counting efficiency.

Table I shows that cycloheximide and vanillin markedly retarded yellowing whereas ABA accelerated it. None of the compounds induced visible symptoms of intoxication. The changes in chlorophyll content were correlated with the changes in protein content as determined after 1 and 2 days, and the rate of protein breakdown as inferred from radioactivity remaining in protein fraction of the discs, preliminary labelled with leucine-^{14}C before treatment with the compounds.

Cycloheximide and vanillin markedly inhibited both protein and RNA synthesis. ABA also reduced incorporation of labelled precursors into protein and RNA, the reduction being correlated with the loss of protein and RNA content. From the data of Table I, it can easily be computed that cycloheximide and vanillin strikingly decreased specific activities of protein and RNA, whereas ABA had little effect on these parameters.

Although cycloheximide and vanillin retarded yellowing in darkness, they accelerated it in light (data not shown).

It has been suggested that cytokinins can retard senescence as a consequence of arrest of protein degradation.[8,9] The same seems to be true for cycloheximide and vanillin (table) and for other inhibitors[1,10] if yellowing in darkness is being taken as a measure of progress of senescence. On the contrary, compounds which accelerate protein breakdown, like abscisic acid (Table I) or 2-chloroethylphosphonic acid (data not shown) stimulate yellowing.

Keeping in mind that vanillin, in comparison to cycloheximide, markedly more effectively inhibited protein synthesis than protein breakdown, it can be concluded that synthesis of some enzymes is also necessary for initiation of senescence processes,

TABLE I

Chlorophyll, protein and RNA in senescing leaf discs of kale treated with cycloheximide (10^{-4} M), vanillin (10^{-2} M) and abscisic acid (10^{-4} M)

		Values at 0 time	Incubation hours[1]	H_2O	Treatment cycloheximide	Vanillin	ABA
Chlorophylls, μg[2]	..	18·0	96D	5·0	15·0	15·6	2·0
Protein, μg	..	87·0	24D +3L	76·7	85·7	78·3	60·0
RNA, μg	..	10·4	24D +3L	9·6	9·5	7·3	7·6
Protein synthesis, dpm	..	..	(24D)+3L	13,404	4,416	468	9,183
RNA synthesis, dpm	..	..	(24D)+3L	426	192	54	324
			Tests on protein breakdown				
Protein, μg	..	90·0[3]	3L +48D	64·8	76·8	70·3	41·4
Protein breakdown, dpm	..	12,411[3]	3L +48D	8,430	12.033	10,010	5,265

[1] D, darkness; L, Light; + means that discs were transferred from darkness to light or *vice versa*.

[2] All data are presented per one disc basis.

[3] Measured after feeding for 3 hours with labelled leucine in light. Values differing by more than 14 per cent. are significant at $p = 0 \cdot 05$.

We thank F. Hoffman-La Roche and Co. Ltd., Basle, for a sample of D, 1-abscisic acid, and the State Board for Peaceful Use of Atomic Energy, Warsaw, for financial support.

Dept. of Plant Physiology,
Institute of Biochem. and
Physiology,
University of Lodz,
Poland, *January* 29, 1971.

J. S. KNYPL.
W. MAZURCZYK.

1. Knypl, J. S., *Flora*, 1967, **158 A,** 230.
2. —, *Biol. Plant.* (Prabha), 1970, **12,** 199.
3. Tevares, J. E., Kende, H. and Berke, E., *MSU. AEC Plant Res. Lab. Ann. Rep.*, 1968, **7,** 93.
4. Knypl, J. S., *Biochem. Physiol. Pfl.* (in press).
5. Lowry, O. H., Rosebrough, N. J., Farr, A. L. and Randall R. J., *J. Biol. Chem.*, 1951, **193,** 265.
6. Cherry, J. H., *Plant Physiol.*, 1962, **37,** 670.
7. Bruinsma, J., *Photochem. Photobiol.*, 1963, **2,** 241.
8. Mizrahi, Y., Amir, J. and Richmond, A. E., *New Phytol.*, 1970, **69,** 355.
9. Kuraishi, S., *Physiol. Plant*, (Cph.), 1968, **21,** 78.
10. Knypl, J. S., *Flora*, 1969, **160 A,** 217.

ON THE OCCURRENCE OF FREE SULPHURIC ACID IN *SPATHOGLOSSUM ASPERUM* J. AG.

IT is well known that species of *Desmarestia* are notoriously acid and collectors of marine algae have always avoided placing *Desmarestia* along with other specimens for fear of injuring them. If injured, the alga turns bluish due to the effect of its acid on the carotenoid pigments. A similar phenomenon has been noticed by the authors in *Spathoglossum asperum* J. Ag., commonly found at Mandapam and the neighbouring islands. A study was made of the aqueous extract of this alga and it was found that the extract was acid, a 150 ml extract from 220 g of fresh *Spathoglossum* registering a pH of 1·4 at 25° C. With barium hydroxide, a precipitate of barium sulphate was readily formed, indicating that the acid was sulphuric acid.

To estimate the acid, 220 g of fresh alga was extracted with 150 ml double-distilled water in a blender for one minute, the blend centrifuged at 3,000 r.p.m. for 10 minutes and the clear supernatant was treated with equimolar quantity of barium hydroxide with stirring to precipitate the acid as barium sulphate. The sulphate was filtered, washed and dried at 60° C. From the weight of the dry sulphate, the value of sulphuric acid was calculated. This was 1·6 g or 0·73% of the fresh weight of the alga. The acid could also be titrated with 0·01 N sodium hydroxide and this procedure also gave very similar results.

It was early demonstrated[1] that the acidity of *Desmarestia* was due to the presence of free sulphuric acid although malic acid[2,3] has been credited with causing the acidity. However, Miwa[4] has shown that free sulphuric acid is abundant in *D. lingulata, D. virides* and *D. tabacoides.* It has been shown[5] also that in *D. munda,* the high acidity is due to the dissociation of 0·025 meq of sulphuric acid and the quantities of organic acids are too low and their pK values too high to account for the observed acidity. The acid has been located[6] in the vacuole and has been determined to be 0·44 N sulphuric acid.

It is interesting to note the presence of the acid in a member of the Dictyotales. The authors examined also other members of the Dictyotales, *viz.*, *Dictyota, Padina* and *Stoechospermum* but the aqueous extracts of all these alga registered pH between 7·0 and 7·2. Thus, *Spathoglossum* appears to be the only member of the Dictyotales to contain free sulphuric acid.

Marine Algal Research Station, V. KRISHNAMURTHY.
K. GANAPATHY.
Mandapam, *January* 23, 1971.

---

1. Wirth, H. E. and Rigg, G. B., *Amer. J. Bot.*, 1937, **24**, 68.
2. Kylin, H., *Planta*, 1938, **27**, 645.
3. —, *Forh. Kgl. Fysiogr. Sallsk. Lund*, 1944, **14** (18), 1.
4. Miwa, T., *Proc. Pacific Sci. Congr.*, *Pac. Sci. Assn.*, *7th Congr.* (Bot.), 1953, **5**, 78.
5. Meeuse, B. J. D., *Biochem. biophys. Acta*, 1956, **19**, 372.
6. Eppley, R. W. and Bovell, C. R., *Biol. Bull.*, 1958, **115**, 101.

CHEMICAL WEED CONTROL IN PINEAPPLE VARIETY KEW*

PINEAPPLE is an important fruit crop of the tropics, and there is a good scope for India to develop pineapple industry and enter into the export trade. The cost of production of pineapple is very high in India compared to the leading exporting countries like U.S.A., Philippines, Taiwan and Malaysia.[1] The major factor which contributes to the high cost of production, is the manual weeding. Thus, the chemical eradication of weeds assumes great importance. Many herbicides have been tried in other countries.[2–7] Dhuria and Leela[8] found that a single pre-emergence spray of CP 44939 at the rate of 4 kg/ha six weeks after planting of pineapple gave satisfactory control of grasses for four months and most of the broad leaf weeds except *Mollugo pentaphylla* L., and *Portulaca oleracea* L. The aim of the present study was to find out a suitable chemical which would give a satisfactory control of weeds found in pineapple fields in India.

A trial on the control of weeds in pineapple variety Kew was laid out on August 19, 1969, at the farm of the Fruit and Vegetable Co-operative Processing Society, Kushalnagar. The common weeds seen in pineapple fields are *Cyperus rotundus* L., *Cynodon dactylon* L., *Pennisetum villosum* R. Br., *Digitaria sanguinalis* L., *Ageratum mexicanum* L., *Bidens pilosa* L., *Lagasca mollis* Cav., *Euphorbia hirta* L., *Amaranthus caturus* Heyne, *Mollugo pentaphylla* L., and *Portulaca oleracea* L. The experiment consisted of seven treatments replicated three times in a randomized block design. The treatments were Bromacil 2 kg, 3 kg and 4 kg per hectare, Diuron 2 kg and 4 kg per hectare, Bromacil 2 kg per hectare + Diuron 2 kg per hectare and control. The area of the plot was 36 square metres. A planting distance of 90 cm × 60 cm × 30 cm was followed. The soil was sandy loam. All the treatments were made as pre-emergence sprays. The data on the dry weight of weeds per square metre were recorded at bimonthly intervals and are given in Table I.

TABLE I

Treatments	Average dry weight of weeds per square meter after a period of	
	2 months	4 months
Coutrol	249·2	287·3
Bromacil 2 kg/ha	4·9	214·3
Bromacil 3 kg/ha	1·5	83·3
Bromacil 4 kg/ha	0·03	24·8
Diuron 2 kg/ha	8·6	137·3
Diuron 4 kg/ha	25·2	83·8
Bromacil 2 kg/ha + Diuron + 2 kg/ha	9·2	69·9

Bromacil at 3 kg and 4 kg/ha gave the best results and excellent control of weeds was obtained for a period of four months. The control was almost complete for the first two months. A good control of weeds was also obtained with Diuron in the early stages. After two months, many plants of nut grass (*Cyperus rotundus* L.) appeared in these plots, whereas Bromacil plots treated particularly at the rates of 3 kg and 4 kg/ha were virtually free from nutgrass. Bromacil at 2 kg/ha in combination with Diuron 2 kg/ha also gave good control of weeds.

Thanks are due to Dr. K. C. Nag of Du Pont Inc. and Shri B. Urs of the Fruits and Vegetable Co-operation Processing Society, Kushal Nagar, for their kind help rendered for carrying out the trial.

Inst. of Horticultural Res., H. S. DHURIA.
255, Upper Palace Orchards, D. LEELA.
Bangalore-6, *September* 16, 1970.

*** Contribution No. 48 of the Institute of Horticultural Research (ICAR), Bangalore-6, India.**

1. *Survey of India's Export Potential of Fresh and Processed Fruits and Vegetables*, Indian Institute of Foreign Trade, 1968, p. 18.
2. Cibes, H. R., *J. Agric. Univ. P. R*, 1957, **41**, 11.
3. Py, C., *Fruits d' outre Mer.*, 1959, **14**. 247.
4. Cannon, R. C., *Qd. Agric. J.*, 1960 **86**, 181.
5. —, *Proc. 2nd Aust. Weed Conf.*, 1960, **16**, 3.
6. Silvy. A., *Rapp. Annu. Instt. France, Rech. Fruit Outre Mer*, 1960–61, Reprinted in *Fruits d' Outre. Mer.* 1962, **17**, 501.
7. Anon, *Not. Agric. Serv. Shell Agric. Venezuela*, 1961, **2**, 115.
8. Dhuria, H. S. and Leela, D., *Proc. 18th International Hort. Congress.*, Tel Aviv, Israel, 1970.

EFFECT OF STEROID HORMONES ON THE BLOOD CONSTITUENTS OF *RANA HEXADACTYLA* AND *CALOTES VARSICOLOR*

THE humoral regulation of red cell production has been the subject of several investigations.[3,4] Alterations in adrenal cortical functions are accompanied by fluctuations in white blood cell counts of peripheral blood.[8] Information in this field is mostly restricted amongst the mammalian species. There is very little evidence that administration of exogenous hormones are capable of exerting a significant influence on the blood constituents of non-mammalian vertebrates. The present study was undertaken to determine the effects of exogenous steroid hormones on the blood constituents of poikilothermic animals.

Estrone.—In this set, each animal received a total quantity of 1·25 mg of estrone. In frogs, this hormone has resulted in the statistically significant level of decrease in haemoglobin level as well as RBC count whereas WBC count has slightly increased. In calotes though there is no significant change in RBC and haemoglobin level, there is a significant increase of neutrophil and lymphocytes.

Cortisol.—The animals of this experimental group received a total of 7·5 mg of cortisol. The haemoglobin content of both the animals shows an increase than normal although it is not statistically significant. In frogs, a significant increase of neutrophil and a decrease of eosinophils and basophils were observed. In calotes WBC count significantly increased due to this steroid administration.

TABLE I

Results showing the hormonal actions on the blood constituents of frogs and calotes (+ indicates increase ; – indicates decrease ; Norm. indicates normal when compared with controls)

		Haemo-globin % g	Total RBC million/ cu. mm	Total WBC million/ cu. mm	Differential count				
					Neutro-phil	Lympho-cyte	Eosino-phil	Basophil	Monocyte
Frog	Testosterone ..	+++	+++	Norm.	Norm.	+++	– –	Norm.	Norm.
	Estrone ..	– – –	– – –	+	,,	Norm.	Norm.	,,	,,
	Cortlsol ..	+	Norm.	Norm.	+++	,,	– –	– –	,,
	DOCA ..	Norm.	– – –	,,	Norm.	,,	Norm.	Norm.	,,
Calotes	Testosterone ..	+++	Norm.	Norm.	– –	+	Norm.	Norm.	Norm.
	Estrone ..	Norm.	,,	,,	+++	+++	,,	,,	,,
	Cortisol ..	+	,,	+++	Norm.	Norm.	,,	,,	,,
	DOCA ..	– – –	,,	– – –	,,	,,	,,	– –	,,

Experiments were conducted with locally available frog, *Rana hexadactyla* (body weight 40–50 g ; length 75–80 mm) and garden lizard, *Calotes varsicolor* (body weight 55–60 g ; length 110–120 mm). They were divided into four groups of five animals each. After two weeks, the experimental animals were sacrificed and blood samples were collected for haemoglobin estimation and total and differential counts[1] of blood corpuscles. To compare with the normal values, Ringer injected control animals were maintained with the experimentals.

Testosterone.—A total of 15 mg was injected in equal dose for 15 days. The haemoglobin content has increased in both the animals studied. In frogs, this hormone results in the significant increase of RBC and lymphocytes and a decrease of eosinophil. In calotes also there is a significant decrease of neutrophil and a slight increase of lymphocytes.

DOCA.—In the last set of experiment, a total of 7·5 mg of DOCA was injected into each animal. A decrease of RBC count was noted in frogs, whereas in calotes this hormone administration has resulted in the significant decrease of haemoglobin content, WBC and basophil counts.

The anabolic action of androgen was established in castrated rats[3] by the decrease of haemopoiesis which has increased on androgen administration. In our present study on poikilothermic animals, similar anabolic action was noted due to the increase of haemoglobin and RBC counts. Estrogens have resulted in the decrease of RBC and haemoglobin and increase of WBC in frogs. In calotes, the neutrophils and lymphocytes have increased. A similar effect has been reported in man.[2] Cortisol administration in the hypophysectomised fishes have resulted in the increase of RBC and WBC.[9] An increase in total RBC of patients treated with cortisone has been reported.[10] Eosinophenia after cortisone administration was also reported.[11] Moreover, the administration of glucocorticoids decrease circulating eosinophil and basophil and the increase of the number of neutrophil.[5-8] It has also been stated that cortisol decreases lymphocytes.[5] Our findings corroborate the earlier report except the lymphocytes have not decreased as in man. DOCA administration has resulted in the decrease of blood constituents of both the animals studied. Thus, the effect of steroid hormones on the blood constituents of *Rana hexadactyla* and *Calotes varsicolor* shows almost a similar pattern as it has been reported in mammals.

Dept. of Biology, S. KASINATHAN.
Jawaharlal Inst. of Postgrad. S. L. BASU.
Medl. Edn. and Res.,
Pondicherry-6, *January* 2, 1971.

---

1. Baker, F. J., Silverton, R. E. and Luckcock, E. D., *Introduction to Medical Laboratory Technology*, 3rd Ed., Butterworth & Co. (Publishers) Ltd., London, 1962, pp. XVIII + 478.
2. Castrodale, D., Bierbaum, O., Elwig, E. B. and Macbryde, C. M., *Endocrinology*, 1941, **29**, 363.
3. Fisher, J. W., *Proc. Soc. Exptl. Biol. Med.*, 1958, **97**, 502.
4. Fruhman, G. J. and Giordon, A. S., *Ibid.*, 1955, **88**, 130.
5. Ganong, W. F., *Review of Medical Physiology*, 2nd Ed., Lange Medical Publications. Maruzen & Co. Ltd., Japan, 1965. pp. XIII + 610.
6. Hamilton, J. B., *Rec. Progr. Hormone Res.*, 1948, **3**, 257.
7. Herbert, P. H. and de Vries, J. A., *Endocrinology*, 1949, **44**, 259.
8. Kowalski, H. J., Reynolds, W. E. and Rutstein, D. D., *J. Lab. & Clin. Med.*, 1952, **40**, 841.
9. Pickforld, G. E., Pang, P. K. T., Weinstein, E., Torretti, J., Hendler, E. and Epstein, F. H., *Gen. Comp. Endo.*, 1970, **14**, 524.
10. Sprague, R. G., Power, M. H., Mason. H. L., Albert, A., Mathieson, D. R., Hench, P. S. and Kendall, E. C., *Arch. Int. Med.*, 1950, **85**, 199.
11. Thorn, G. W., Renold. A. E., Wilson, D. L., Frawley, T. F., Jenkins, D., Garciareyes, J. and Forsham, P. H., *J. Med*, 1961, **245**, 549.

GAMMA-RAY INDUCED VARIABILITY IN THE IODINE VALUE OF LINSEED OIL

OF the three objectives of linseed breeding, namely, increasing the seed yield, oil content of the seed and improving the oil quality (iodine value of the oil) the last one is the most important as the linseed oil is the most widely used drying oil in paints and varnishes. The drying quality of the oil is dependent on the quantity of oxygen it absorbs in the processes of drying and this is determined by the absorption of iodine (instead of oxygen) per unit quantity of oil. A good drying oil should have a high iodine value between 180-200. The market value of linseed depends upon the iodine value of its oil. The mutation experiments conducted with one of the varieties of linseed (*Linum usitatissimum* L.) showed that the increased variability induced by gamma irradiation could be exploited for evolving strains with high iodine value.

Dry seeds of the linseed variety NPRR 9 were irradiated with 40, 60 and 80 kilo Rads of gamma-rays and the progeny carried through from R_1 to R_4 selfed generation. A few cultures of the R_4 generation selected for their good yield and other desirable agronomic characters were analysed for their seed oil content and iodine value of the oil. The analysis was done as accurately as possible using duplicate and even triplicate sets. The data are given in Table I. Since only a few samples were analysed, the data were not subjected to statistical analysis. As the cultures were in the fourth generation, they are expected to have stabilized with regard to the various characters including the iodine value and breed true to this character in the subsequent generations particularly for the iodine value with which we are mostly concerned here.

It is seen from Table I that the variation in iodine value is more than that of the oil content. The maximum increase in iodine value was 16·1 units over the untreated parental strain while the maximum increase in the oil content was 1·6 units only. This shows that iodine value is more amenable to manipulation by mutation breeding perhaps due to its simple nature of inheritance. Mutation breeding seems to be especially useful in changing simply inherited characters in highly developed genic systems where the standard hybridization methods may disturb the superior combination of genes. Arny[1] found that in crosses, the F_1 resembled the low iodine index parent, segregation occurred in F_2 and a 1 : 1 ratio was obtained in the back-crosses indicating that a single factor pair was responsible for the main difference in quality. Oil per cent, on the other hand, is not a simple case of one trait being dominant, another recessive, but a condition of quantitative inheritance in which several sets of genes govern the characteristic.

Comstock[2] raised the oil percentage by 1·5 points in one cross and by 1·9 in another. In

TABLE I

Oil content and iodine value in R_4 generation

Treatment		Sample No.	Oil %	Unit increase/ decrease over control	Iodine value of oil	Unit increase/ decrease over control
40 kR gamma-rays	..	1	42·9	+1·2	160·4	+16·1
,,	..	2	42·5	+0·8	152·9	+ 8·6
,,	..	3	43·3	+1·6	152·5	+ 8·2
,,	..	4	42·1	+0·4	144·2	− 0·1
,,	..	5	42·3	+0·6	148·8	+ 4·5
,,	..	6	40·25	−1·45	149·1	+ 4·8
60 ,,	..	7	42·15	+0·45	148·5	+ 4·2
,,	..	8	41·05	−0·65	141·5	− 2·8
,,	..	9	38·9	−2·8	144·8	+ 0·5
,,	..	10	41·9	+0·2	140·2	− 4·1
,,	..	11	41·8	+0·1	147·1	+ 2·8
,,	..	12	41·9	+0·2	150·8	+ 6·5
,,	..	13	41·6	−0·1	149·7	+ 5·4
80 ,,	..	14	42·7	+1·0	152·7	+ 8·4
,,	..	15	42·8	+1·1	131·5	−12·8

R_1 = The immediate generation following seed irradiation and R_4 the fourth generation.

the present experiment it was raised by 1·6 points in NPRR 9.

In agreement with the findings of Harpstead[3] the irradiation studies on NPRR 9 indicated that irradiation was an effective means of increasing genetic variability and that selection for higher iodine number could be successfully carried out in the irradiated progenies, as of the three characteristics, oil content, iodine number and 1000-grain weight, iodine number is the most constant.[5] In NPRR 9 comparatively greater variation in iodine value than in oil percentage was obtained. Harpstead[3] also obtained low estimates of heritability for seed yield, and oil percentage. As a result of individual selection in neutron-irradiated material lines superior in productivity, lodging resistant and superior in oil content to the original untreated parental forms of linseed were obtained by Priadcencu *et al.*[4]

The authors are grateful to Dr. A. R. S. Kartha, Organic Chemist, Division of Soil Science, I.A.R.I., New Delhi, for kindly analysing the samples for oil content and iodine value of the oil.

Division of Genetics, D. SRINIVASACHAR.
I.A.R.I., New Delhi, R. S. MALIK.
February 20, 1971.

1. Arny, A. C., *Proc. Min. Acad. Sci.*, 1936, **4**, 29.
2. Comstock, V. E., *Minnesota Agric. Exp. Sta. Tech. Bull.*, 1960, p. 234
3. Harpstead, D. D., *Diss. Abstr.*, 1962, **22**, 2551 (Abst.).
4. Priadcencu, A., Avramoie, P. and Dowcet, V., *An. Inst. Centr. Cerc. Agric. Bucuresti*, 1961, Ser. C, **29**, 37.
5. Remussi, C., Oribe, E. I. and Iviglia, P., *Rev. Fac. Agron. B. Aires.*, 1967, **16**, 67.

ISOLATION AND CULTURE OF MYCOPLASMA ASSOCIATED WITH CITRUS GREENING DISEASE

MYCOPLASMA-LIKE bodies have been found associated with several yellows type of plant diseases including two serious diseases of citrus —greening and stubborn.[1–3] Mycoplasmas associated with some of these diseases have also been cultured and diseases reproduced;[4,5] however, a majority are yet to be brought in culture. Here we report culturing of mycoplasma associated with citrus greening disease in semi-synthetic media.

The disease was maintained on *Citrus sinensis* plants infected by grafting. For culturing, the leaves were thoroughly washed, small portions containing phloem cells cut, surface sterilized with mercuric chloride, homogenised in tissue grinder with a small quantity of double distilled water and the homogenate streaked on agar media in petriplates or incorporated in broth. Several different media were tried but the medium containing: 3·4% dehydrated bacto PPLO agar or PPLO broth with crystal violet (Difco Laboratories, U.S.A.) and 20% rabbit serum, supported best growth. The pH was adjusted to 7·8 and the plates or tubes were incubated at 30° C.

On agar medium typical minute colonies with burrowing centre developed in 24 to 48 hr (Fig. 1). Similarly, in broth cultures turbidity developed in 24 to 48 hr. The colonies were successfully transferred from agar to broth and *vice versa*. The colonies were stained by Dienes'[6] stain described by Hayflick.[8] The colonies containing pleomorphic bodies took dense blue stain confirming the mycoplasmal nature of the colonies.

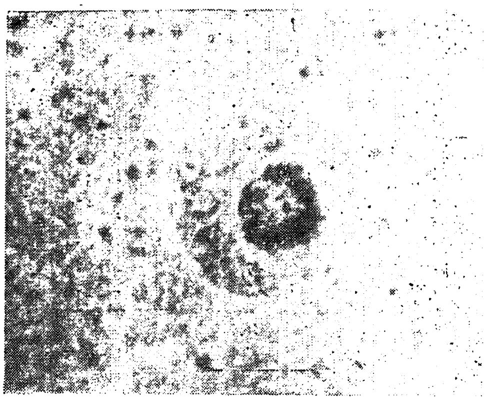


FIG. 1. Mycoplasma colony from citrus greening.

Further experiments to study the structure of the mycoplasma in culture and to reproduce the disease by inoculating citrus plants artificially, are in progress. The plants from which the material was taken for culturing are also responding favourably to tetracycline treatments.

The authors are thankful to Dr. M. S. Swaminathan, Director, I.A.R.I., New Delhi, for the interest and encouragement, and the Indian National Science Academy, New Delhi, for financial grant.

Division of Mycol. and Plant Pathology,
Indian Agric. Res. Inst.,
New Delhi-12,
April 27, 1971.

S. K. GHOSH.
S. P. RAYCHAUDHURI.
ANUPAM VARMA.
T. K. NARIANI.

---

1. Doi, Y., Teranaka, M., Hora, K. and Asuyama, H., *Ann. Phytopath. Soc. Japan*, 1967, **33**, 259.
2. Lafleche, D. and Bove, J. M., *C. R. Acad. Sci.*, 1970, **270**, 1915.
3. Whitcomb, R. F. and Davis, R. E., *Ann. Rev. Entomol.*, 1970, **15**, 405.
4. Chen, T. A. and Granados, R. R., *Science*, 1970, **167**, 1633.
5. Lin, S., Lee, C. and Chin, R., *Phytopathology*, 1970, **60**, 795.
6. Dienes, L., *J. Infect. Dis.*, 1939, **65**, 24.
7. Hayflick, L., *Tex. Rep. Biol. Med.*, **1965**, **23**, (Suppl. 1), 285.

SEED TREATMENT OF *VICIA FABA* L. WITH TERRAMYCIN IN COMBINATION WITH EMULGATOR NP_{10}

TERRAMYCIN has been reported to reduce the reproductive capacity of aphids to a great extent and its activity is much increased when combined with emulgator NP_{10}.[1,2] Terramycin may be taken up by the plants of *Vicia faba* L. through root application or spray on stem and leaves.[3,4] There is no report on the activity of terramycin through seed treatment. An experiment was, therefore, conducted to see the effect of seed treatment of *V. faba* with terramycin combined with emulgator NP_{10}.

Seeds of *Vicia faba* L. (variety "Ackerperle") were obtained from the experimental farm of Phytopathology Institute of Giessen University, W. Germany. A stock solution of terramycin at 0·2% concentration was prepared in combination with emulgator NP_{10} at 0·1% concentration. Emulgator NP_{10} is an oxyethyl phenyl derivative. The seeds were dipped for 6, 12, 24, 48 and 72 hours in the solution of terramycin combined with emulgator NP_{10}, while the seeds of control group were dipped in distilled water. The seeds were then sown in small earthen pots filled with a mixture of sterilized soil, turf and sand.

It was found from the experiments that terramycin has toxic effects in the seeds of *V. faba*, which damages the seed embryos. The seeds kept in the solution of terramycin + emulgator NP_{10} for 72 and 48 hours could not germinate at all, while those treated for 24 and 12 hours could germinate, but the newly-germinated seedlings could survive only for two to three days. The seeds treated for six hours germinated normally but the seedlings died mostly after six to seven days. It was also observed that due to application of terramycin in combination with emulgator NP_{10}, there was no development of side roots in the young plants of *V. faba*. Possibly, certain essential enzymes responsible for the growth of seed-embryo and for further development of seedlings are destroyed by the seed application of terramycin, due to which there is abnormal seed germination and death of seedlings.

The author is indebted to Prof. Dr. H. Schmutterer of Giessen University, West Germany, for his guidance. The award of a scholarship by the German Academic Exchange Service is gratefully acknowledged.

Division of Entomology, O. P. LAL.
U.P. Inst. of Agric. Sciences,
Kanpur, U.P., *January* 31, 1971.

---

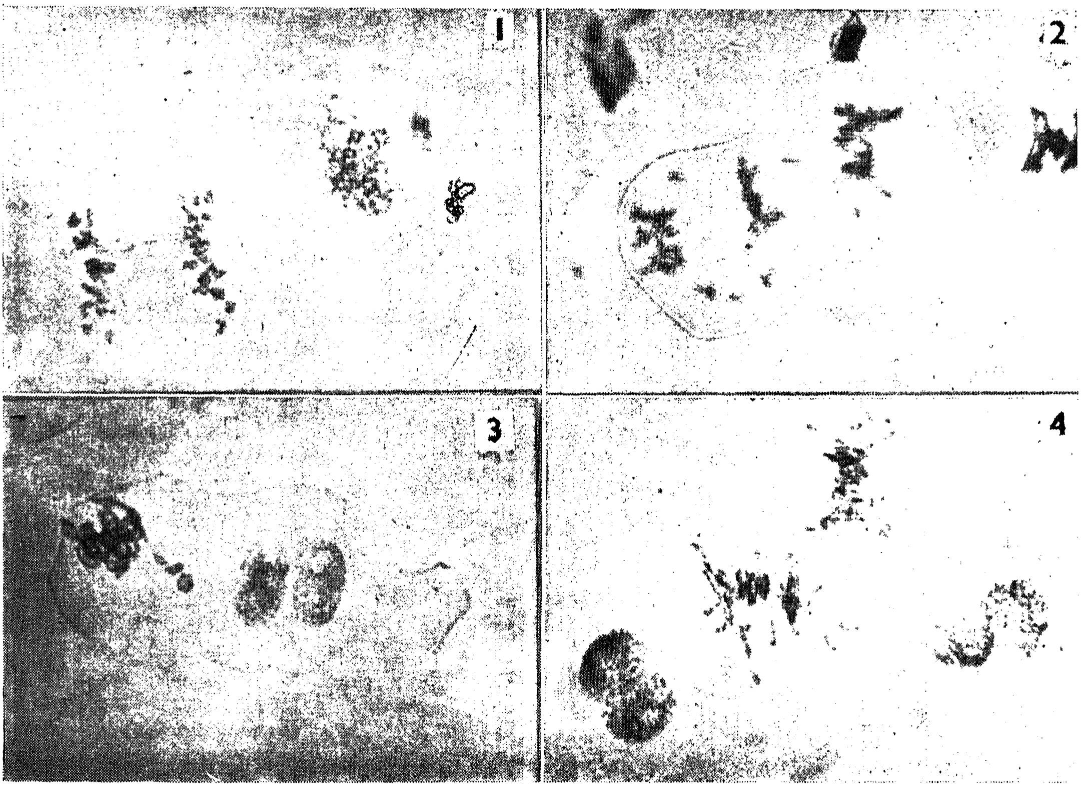
1. Ehrhardt, P. and Schmutterer, H., *Z. Morph. Okol. Tiere*, 1966, **56**, 1.
2. Lal, O. P., *Dissertation*, Giessen University, W. Germany, **1969**.
3. Jayaraj, S. and Schmutterer, H., *Z. Pflanzenk. Pflanzenschutz*, 1966, **73**, **660**.
4. —, and —, *Ann. Appl. Biol.*, 1967, **59**, **13**.

MULTINUCLEATE POLLEN MOTHER CELLS IN *TRITICALES*

UNINUCLEATE condition of the pollen mother cells is typical of all *angiosperms*. But, deviations from this general pattern, although rare, are reported to have occurred.[1]

Triticales, $2n = 8x = 56$, is an allo-octoploid of an intergeneric cross *Triticum aestivum* ($2n = 6x = 42$) × *Secale cereale* ($2n = 14$). A total of 250 such *Triticales* lines obtained through the kind courtesy of Dr. D. M. Leuwrick of Ford Foundation, New Delhi, was grown in this Institute during 1969-70 winter for evaluating their breeding potential. Of these, 82 were cytologically tested at meiotic level from the Feulgen-stained anther squash preparations. All the lines were found to have meiotic irregularities of the usual types like pairing failure, I- and II-anaphase chromosomal non-disjunctions, laggards, micronuclei, etc., though to a varying degree. However, one of the lines, HTC-621, was having an additional type of abnormality which the others did not have; and that was the presence, in certain percentage of cells, of more than one nucleus. This appeared to be rather an unusual situation.

The aberrant pollen mother cells were of giant size, having in each of them a number of nuclei varying between two to six (Figs. 1-4). These cells were either linear or spherical in shape, and in size approximated in proportion to the number of nuclei they contained. The cells with linear appearance had visible constrictions at the positions where the



FIGS. 1–4. Pollen mother cells with more than one nuclei in *Triticales*. Fig. 1. Pollen mother cell with two nuclei in asynchronous division. Figs. 2–3. Pollen mother cells with three nuclei in various divisions. Fig. 4. Pollen mother cell with six nuclei.

normal intercellular septa between the nuclei should have been present (Figs. 1, 2). Nuclei in these cells were either in interphase or in various division stages, but were either synchronous or not (Figs. 2, 3, 4).

Relatively scanty literature available to-date on the subject reflects the rarity of the phenomenon of the multi- or the polynucleate condition of the pollen mother cells in *angiosperms*. Further, its occurrence only in one out of 82 lines also rules out the possibility of its being a general feature among *Triticales*. Again, it cannot also be considered as fortuitous in view of its presence in more than one plant of the line in which it was discovered.

Polynucleate condition was reported by Matsura (*cf.* Maheswari[1]) in *Phacellanthus*. It was also reported in two haploid plants of *Phleum pratense*,[2] in which there were 30 nuclei united to form what are called plasmodia or "syncytes". In *Trillium erectum*, Stern[3] reported as many as 32 nuclei in one single cell. However, there were no cells with more than 6 nuclei in the present material, and, presumably, this is a new record for *Triticales*.

According to Matsura,[1] they result from the fusion of adjacent cells by dissolving the intercellular walls. However, it is not explained why the intercellular septa gets dissolved and if it did, at what stage of the nuclear division. Moreover, it is also not very clear from this study. Nevertheless, it may be supposed that they arise as a result of failure of cytokinesis following nuclear division during one or two premeiotic-mitotic cycles in the sporogenous tissue.

Polynucleate pollen mother cells were more predominant in hybrids and haploids[2,4] and they were attributed to innate "unbalance" in the cell. Rees[5] has established that the chromosomes, both in form and function, are bound by genetic regulations. Mitotic sequences including cytokinesis may not, therefore, be exceptions. Then the arrest of the cell-wall formation after the karyokinesis at premeiotic stage might be supposed to be the function of the gene or gene system. But the obvious heterogeneity between the pollen mother cells in the sporogenous tissue in the matter of nuclear composition might be an outcome of the inconsistent manifestation of the relevant genetic system. This kind of functioning of the gene is possibly due to the accumulation in homozygous condition of the deletrious recessives in the *Triticales* genotype and the likely variation in the manner of their interaction with the given environment in the background of *Triticum* and *Secale* genomes which oppose each other in their breeding systems.

Apparently, polynucleate condition, whether occurring through the failure of cytokinesis or through the disappearance of intercellular wall, is rather a rare phenomenon. Yet when it occurs, it may have some evolutionary significance, for it may lead to the development of higher forms through the polyploid gametes.

Thanks are due to the Council of Scientific and Industrial Research, India, for their generous financial help to one of the authors (A. S.).

University of Agric. Sci.,
Bangalore-24, India,
August 17, 1970.

C. KEMPANNA.
A. SEETHARAM.
G. SHIVASHANKAR.

---

1. Maheswari, P., McGraw-Hill Book Company, Inc., 1950, p. 41.
2. Levan, A., *Hereditas*, 1941, **27**, 243.
3. Stern, H., *J. Heredity*, 1946, **37**, 47.
4. Wood Worth, R. H., *J. Arnold Arboretum*, 1931, **12**, 23.
5. Rees, H., *Bot. Rev.*, 1961, **27**, 288.

INHIBITION OF ABSCISIC ACID INDUCED CHLOROPHYLL DEGRADATION BY POTASSIUM

ABSCISIC acid (ABA), the best characterised naturally-occurring, senescence-promoting, abscission-accelerating and growth-inhibiting hormone, now ranks in importance with auxins, gibberellins, and cytokinins as a plant growth-controlling factor.[1] An interaction between ABA, auxins, gibberellins and cytokinins has been reported in several systems.[1-4] To our knowledge, almost no work has been done on interaction between ABA and nutrient supply. This report describes the reversibility of one of the ABA effects (promotion of chlorophyll degradation) by exogenously added potassium.

Ten-millimeter leaf discs were punched from the mature leaves of *Brassica juncea*. Separated leaf discs, in lots of 10, were placed in petri-dishes containing a single layer of filter-paper moistened with 5 ml of distilled water or an equivalent amount of the test substance in aqueous solution. After incubation in dark at 28° C for the desired time (Table I), the chlorophyll of five discs was extracted with 10 ml solution of 80% acetone and the optical density of the extract measured at 665 nm with the help of a Hilger's spectrophotometer.

The results presented in Table I clearly indicate that, as in other species,[3-6] ABA promoted the degradation of chlorophylls in the leaf discs of *Brassica* also. On the other hand, discs incubated in appropriate solutions of gibberellic acid (GA), potassium nitrate (KNO_3) and potassium chloride (KCl) remained green for a long time (Table I). The chlorophyll content of leaf discs incubated in these substances was about two or three times higher than the water control, and 4-5 times more in comparison to those reared in ABA solution. All the three chemicals tested, *viz.*, GA, KNO_3 and KCl successfully reversed the promoting effect of ABA on chlorophyll degradation. This is indicated by the fact that the leaf discs reared in ABA (5 ppm) in presence of GA, KNO_3 or KCl had as much as about five times more chlorophyll than those floated on ABA solution alone, although the tissue of some of these discs indicated appreciable loosening and softening (Table I). Further, it was interesting to note that despite the higher chlorophyll content, the level of protein nitrogen in these discs was not significantly different from that of the control discs (data not shown).

TABLE I

*Effect of ABA, GA, KNO_3 and KCl on chlorophyll degradation**

Treatment		Degree of tissue softening	Optical density (after 4 days)
Water	..	+	0·44
ABA 5 ppm	..	++	0·20
GA 10 ppm	..	+	0·950
KNO_3 1,000 ppm	..	+	1·125
KCl 1,000 ppm	..	+	1·025
ABA 5 ppm + GA 10 ppm		+++	0·60
ABA 5 ppm + KNO_3 1000 ppm		++++	0·950
ABA 5 ppm + KCl 1,000 ppm		++++	0·84

* Values represent optical density of 10 ml solution extract of 5 leaf discs. Initial O D., 1·275.

According to the current view, the hormonal retardation of leaf senescence is linked with the maintenance or the enhancement of protein and RNA synthesis, and is often controlled through maintenance of DNA as a functional template for DNA-dependent RNA-synthesis.[5] The ability of ABA to promote the degenerative changes of senescence are indicative of the shift in the patterns and levels of enzymatic activities. In *Arabidopsis* leaf discs, we have observed that ABA hastens senescence through its effect on chlorophyll, protein and RNA metabolism.[6,7] It is most striking to observe that in addition to GA symptoms of action of ABA can be partly reversed by KNO_3 and KCl. Therefore, although it should be more thoroughly tested, it might be that these chemicals inhibit the ABA induced synthesis of some specific proteins (enzymes) which catalyse degradation of the chlorophylls. Incidentally, it may be noted that KCl is also known to reverse inhibition of chlorophyll synthesis caused by growth retardants and coumarin.[8]

The kind gift of ABA from Prof. J. W. Cornforth is gratefully acknowledged.

Botany Dept., NARENDRA SANKHLA.
University of Jodhpur,
Jodhpur, *January* 29, 1971.

---

1. Addicott, F. T. and Lyon, J. L., *Ann. Rev. Pl. Physiol.*, 1969, **20**, 139.
2. Chrispeels, M. J. and Varner, J. E., *Nature*, 1966, **212**, 1066.
3. Sankhla, N. and Sankhla, D., *Experientia*, 1968, **24**, 294.
4. — and —, *Physiol. Plant.* 1968, **21**, 190.
5. Osborne, D. J., *Sym. Soc. Exp. Biol*, 1967, **21**, 305.
6. Sankhla, N., *Arabid. Inf. Serv.*, 1970, **7**, 16.
7. —, *Ibid.*, 1970, **7**, 18.
8. Knypl, J. S., *Nature*, 1969, **224**, 1025.

TRICHOTHECIUM ROSEUM, MYCOPARASITIC ON *CERCOSPORA BLUMEAE*

A MYCOPARASITE was observed on *Cercospora blumeae* Thuemen parasitic on the leaves of *Blumea* sp. during October, 1970, at Varanasi, Uttar Pradesh. The effuse, hypophyllous, sooty mold-like growth of *Cercospora* covering the entire undersurface was overgrown by an ashen-white, fluffy mycelium in scattered patches. The mycoparasitic fungus was isolated by dilution plate technique. The colonies were dull white at first and turned pinkish finally. Leaves of *Blumea* with *Cercospora* infection free from the mycoparasite and retained under moisture for 3 hr, were dusted with conidia of the mycoparasite from 5-6 days old-plated cultures and incubated at room temperature (22-24° C). Control blanks were maintained for comparison. A whitish growth of the mycoparasite appeared within 48 hr. Reisolations yielded morphologically similar cultures. The undusted controls and healthy leaves inoculated with the mycoparasite remained uninfected.

The colonies were pinkish and fluffy. The long, slender conidiophores were septate and usually swollen at the tips (Fig. 1). The pinkish bicelled, pear-shaped conidia were borne singly, but remained adherent in clusters at the tip of the conidiophore and measured 10-20·7 × 4·3-10 μ (Fig. 2). Diagnostic morphology of the pathogen indicated its identity to *Trichothecium roseum* Link, to which it is referred.

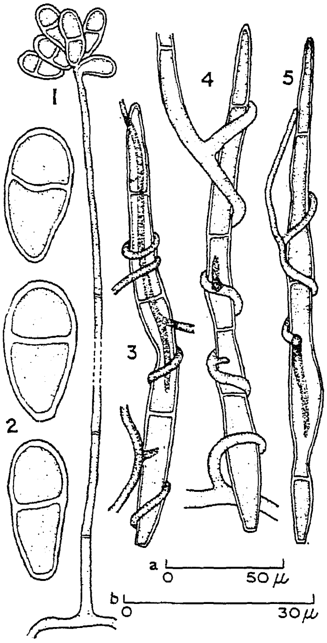


FIG. 1–5. Figs. 1–2. Conidiophore and conidia of *Trichothecium roseum*; Figs. 3–5. Development of mycoparasite on conidia of *Cercospora blumeae*. (Scale *a*; Fig. 1; *b*; Figs. 2–5).

Scraped mounts in lactophenol lightly stained with cotton-blue showed that the mycoparasite attacked the aerial growth of conidiophores and conidia of *Cercospora blumeae*, establishing an intra-lumenar parasitic network of slender hyphae, 1·5 to 2 μ in diam. (Figs. 3, 5) or by coiling tightly around the sporophores and conidia (Fig. 4) and/or by combination of both (Fig. 3). Penetration of the host hyphae was effected by slender infection hyphae arising from the advancing tip or by infection pegs from the coiling hyphae piercing in at the point(s) of contact (Fig. 4). The hyphae traversed in the lumen consuming the protoplasm of the host cells leaving them devitalized and shrivelled, while the external ones formed a network. The modes of parasitism resembled those of *Rhizoctonia solani* Kuehn.[1]

Trochothecium roseum has been reported earlier mycoparasitic on *Puccinia graminis tritici* (Pers.) Erikss. and Henn.[3] and *P. erianthi* Padw. and Khan.[2] *Cercospora blumeae* forms an additional host fungus for the mycoparasite.

Faculty of Agriculture, Y. RATHAIAH.
Banaras Hindu University, M. S. PAVGI.
Varanasi-5, *February* 15, 1971.

---

1. Butler, E. E., *Mycologia.*, 1957, **49**, 354.
2. Chona, B. L., Durgapal, J. C., Gugnani, H. C. and Sohi, H. S., *Indian Phytopath.*, 1965, **18**, 386.
3. Sreekantaiah, K. R. and Joshi, L. M., *Ibid.*, 1958, **11**, 62.

REVIEWS AND NOTICES OF BOOKS

Beautiful Gardens. By M. S. Randhawa. (Published by the Indian Council of Agricultural Research, Dr. Rajendra Prasad Road, Krishi Bhawan, New Delhi), 1971. Pp. 168. Size 21 cm × 27 cm. Price Rs. 29·50.

It is a pleasure to peruse this luxury volume on *Beautiful Gardens* with its gorgeous coloured plates and evocative description of the beautiful flowering trees of India. The author, himself a naturalist, a scientist, a writer and an artist, has taken a lifetime interest in trees, gardens, forests and the countryside and has travelled wide and through all parts of the country in pursuit of this interest. In this "saga of the Tree Beautiful", he has conveyed the joy of his experience to those who have themselves enjoyed such arboreal grandeur in Nature and in the stately gardens of the country and elsewhere.

The folk-songs of yore associated with trees, and collected from various regions of India speak for themselves and conjure up the past —the lives of the simple villagers and the tribal people, their faith, their love, and their romance.

The book also gives interesting information about exotic trees and plants including some recent introductions. In this connection, the author emphasizes the need for "a systematic, organized effort to place the plant exploration and introduction work on a sound national footing". Garden lovers will find useful information on garden planning, about ornamental foliage trees, unusual trees for the curious, and shrubs and trees noted for their fragrant flowers.

There are 18 plates (and a frontispiece) in colour of trees in bloom, and 12 plates in black and white depicting views of some noted gardens of India. While the dust-cover reproduces the coloured plate "the flame of the forest", the binding itself is in drab black. The choice of a brighter colour would have been more appropriate for its place in the bookshelf of the interested reader. A. S. G.

Photoelectronic Imaging Devices—Vol. 1: Physical Processes and Methods of Analysis. Edited by L. M. Biberman and Sol Nudelman. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1971. Pp. xxiv + 439. Price $ 45.00.

Photoelectronic devices are fundamentally based on the principle of emission of electrons from sensitive surfaces exposed to light or, in general, to electromagnetic radiant energy. The imaging devices, which are capable of sensing radiation in both the visible and infrared portions of the spectrum, are concerned with formation and detection of images at very low radiant energy levels. Their use in television cameras is well known, and the image tube of cascaded type plays an important role in observational astronomy, optical as well as radio. The device essentially consists of a lens, the photocathode, electron acceleration and focussing stages, and a phosphor screen. Theoretically, the performance of the device is measured by the ratio of the output photons at the phosphor to the input photons on the photocathode. However, in practice, the human eye is the ultimate judge of the efficiency of any system made to specification. The use may be, as for example in an infrared device, to find a brown crocodile in a blue river at full moon or to see terrain features on moonless nights with near daylight acuity.

During the past decade, a great impetus has been given to the study of photoelectronics and this is in a large measure due to the developments in new forms of solid-state devices. Sophisticated researches in this field have been so far confined to major industrial development laboratories chiefly concerned with the manufacture of television tubes, image intensifiers and photoelectronic system devices; thus expertise in this important branch of study has been limited to such laboratories only.

A good deal of fundamental knowledge of theory and technology is involved in the development and fabrication of photoelectronic devices, and there is a need for universities to institute specialised courses on the subject at under-graduate and graduate levels of teaching. Realising this, the University of Rhode Island has initiated a course on "Photoelectronics". A series of intensive lectures governing the pertinent fundamentals of physics and covering most of the imaging devices prevalent in this growing technology was given in two successive programs held at the University during the summers of 1968 and 1969.

The outcome of these two summer school programs in which experts in this field of study from University, Government and industrial laboratories took part is the publication of the two volumes on "Photoelectronic Imaging Devices".

This publication is the first of its kind which may be used as text and instructional guide for such courses for students of electrical engineering.

Volume I under review deals with physical processes and methods of analysis. It is in four parts. Part I is on Radiometry, Radiance and Vision; Part II on Basic Functions includes chapters on photoconductivity, photoemissive cathodes, noise performance and electron optics. Part III on Analysis deals with specifications, transfer characteristics, modulation and resolution; and Part IV on Introduction to Systems deals with system analysis, system evaluation, and backscatter effects.

A. S. G.

General Topology. By Stephen Willard. (Addison-Wesley Publishing Co., Reading, Massachusetts), 1970. Pp. xii + 369. Price 126 *sh.*

This text-book is intended for one- or two-semester courses on topology for graduate students of mathematics who have had a rigorous course in advanced calculus or real analysis. The book presents a balanced treatment between the two broad areas of general topology, namely, continuous topology and geometric topology. The first is represented by sections on convergence, compactness, metrization and complete metric spaces, uniform spaces and function spaces. The second concerned with the connectivity properties of topological spaces is dealt with in sections under connectivity properties, topological characterization theorems and homotopy theorem.

The development of the treated matter allows for flexibility. A large index, bibliography and historical notes add to the usefulness of the book as a source of reference.

A. S. G.

Algebraic Number Theory. By Serge Lang. (Addison-Wesley Publishing Co., Reading, Massachusetts), 1970. Pp. xi + 354. Price 140 *sh.*

The present publication supersedes the author's previous book, *Algebraic Numbers* and includes a great deal of new material, especially the class field theory. The point of view in the treatment is principally global, and local fields are dealt with only incidentally. The subject-matter is in three parts: Part I: General Basic Theory; Part II: Class Field Theory; and Part III: Analytic Theory.

The book will serve as a useful text on the subject for courses on modern algebra for graduate students.

A. S. G.

Fundamentals of Automatic Control. By S. C. Gupta and L. Hasdorff. (Wiley Eastern Private, Ltd., J/41, South Extension 1, New Delhi-49), 1970. Pp. 583. Price Rs. 27·00.

This book first published in U.S. in 1970 at $ 15.95 is now made available to students as the Wiley Eastern Reprint at the low cost of Rs. 27·00 only. Designed for the standard first course in automatic control theory, the book presents a consolidated approach to continuous and sampled-data control systems. The classical techniques are discussed in detail both for analysis and compensation. The state variable techniques are also discussed thereby laying the foundation for modern control theory.

In keeping with the present-day trend several numerical examples have been solved through the use of digital computer. This will encourage the reader to use the computer, wherever appropriate, in solving problems given at the end of each chapter.

A. S. G.

Biochemistry Laboratory Techniques. By S. Chaykin. (Wiley Eastern Private, Ltd., J/41, South Extension 1, New Delhi-49), 1970. Pp. 169. Price Rs. 10·00.

First published in U.S. in 1966 at $ 5.95 this Wiley Eastern Reprint makes this laboratory manual available at a price low enough to enable each student of biochemistry own a copy. This useful manual provides the beginning biochemistry graduate student with a basic working knowledge of a wide variety of laboratory techniques currently in use in biochemical research. The contents include buffers, protein determination, properties and preparation of yeast alcohol dehydrogenase, sephadex and gel filtration radioisotopes in biochemical research, oxidative phosphorylation, bacterial genetics, etc.

A. S. G.

Books Received

Text-Book of Plant Anatomy. By P. K. Daradhiyar and (Mrs.) Renuka Daradhiyar. (Bharati Bhawan, Exhibition Road, Patna-1), 1970. Pp. 175. Price Rs. 6.

A Review of 'Beef in Ancient India'. (Gita Press, Gorakhpur), 1971. Pp. viii + 223. Price Rs. 2.

Quantum Particle Dynamics. By P. G. Puranik. (S. Chand and Co. P. Ltd., Ramnagar, New Delhi-55), 1971. Pp. xi + 315. Price Rs. 25.

Laser Interaction and Related Plasma Phenomena. Edited by H. J. Schwarz and H. Hora. (Plenum Pub. Corpn., New York), 1971. Pp. xiv + 508. Price $ 25.00.

Pulse Crops of India. (Indian Council of Agricultural Research, New Delhi), 1970. Pp. 334. Price Rs. 15·50.

Seminars in Mathematics—V.A. Steklov Mathematical Institute, Leningrad—(Vol. 12): *Investigations in the Theory of Stochastic Processes.* Edited by V. N. Sudakiv. (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011, U.S.A.), 1971. Pp. vii + 98. Price $ 15.00.

Problems in Mathematical Analysis (Vol. 2)—*Linear Operators and Operator Equations.* Edited by Acad. V. I. Smirnov. (Plenum Pub. Corpn., New York), 1971. Pp. v + 129. Price $ 16.00.

Microhardness of Metals and Semiconductors. By V. M. Glazov and V. N. Vigdorivich Plenum Pub. Corpn., New York), 1971. Pp. xv + 226. Price $ 30.00.

2807-71. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, L.P.T., Superintendent, at The Bangalore Press, Bangalore-18.

X-RAY STUDY OF COLD-WORK AND RECOVERY IN TUNGSTEN

R. K. GUPTA AND T. R. ANANTHARAMAN

Department of Metallurgical Engineering, Banaras Hindu University, Varanasi-5

ABSTRACT

X-ray line broadening in freshly cold-worked and partially annealed tungsten filings has been subjected to Fourier analysis. Values of small domain size, microstrains and dislocation densities have been estimated. Annealing for an hour at 300° C is shown to reduce the dislocation density in the filings from $3{\cdot}30 \times 10^{11}$ to $1{\cdot}68 \times 10^{11}$ cm/cm.^{3} The flow stresses estimated from dislocation densities at different temperatures are found to approximate to measured yield stress values for an annealed sample extrapolated to an extremely high strain rate.

INTRODUCTION

X-RAY line shape analysis of cold-worked metals is done in terms of small domain size, microstrains and stacking faults within these domains. These features are all a manifestation of the complex dislocation substructure in cold-worked metals and a categorization is made only for convenience in analysis. With modern X-ray diffractometer techniques it is now possible to separate out these causes of X-ray line broadening quantitatively with a reasonable degree of confidence.

The object of the present paper is to study the recovery of dislocation density in cold-worked tungsten on annealing at increasing temperatures. Owing to the elastic isotropy and absence of stacking faults on cold-work in tungsten, it is possible to attempt an empirical correlation of the X-ray line broadening results in terms of small domain size and lattice strain with the mechanical properties of the metal.

EXPERIMENTAL PROCEDURE

High-purity tungsten (99·99%) was deformed by filing at room temperature (30° C). The resultant filings were screened through 0·075 mm classifiers and compacted to the required briquette shape for the diffractometer holder. X-ray diffraction peaks were chart-recorded in a Philips X-ray Diffractometer with a scanning speed of 1/8° (in 2θ)/minute, using filtered CuK$_\alpha$ radiation. The deformed filings were annealed for one hour under high vacuum ($\sim 10^{-5}$ torr) successively at 300° C, 550° C and 800° C. The X-ray diffraction peaks were chart-recorded from hand-packed briquettes of these filings. Well-annealed tungsten powder (G.E. Standard) was used for recordings of X-ray diffraction peaks under identical conditions to correct for instrumental broadening.

To determine accurately the background level of the broadened peaks the comparison method after Sato[1] was employed. Intensity data from broadened and standard diffraction peaks were used for computation (with an IBM 7044 computer) to arrive at the values of Fourier coefficients corrected for instrumental broadening by the Stokes[2] method.

EXPERIMENTAL RESULTS

Tungsten is an element of high stacking fault energy and thus the contribution to the broadening of X-ray diffraction peaks by stacking faults is negligible. To separate out the effects of strain and domain size, the Warren-Averbach method[3] was followed. The experimentally determined Fourier coefficients (after Stokes correction) A_L are given in this method by

$$A_L = A_L^P \cdot A_L^D \qquad (1)$$

where the particle size coefficients A_L^P represent the effect of small domain size and are independent of the order of reflection, while the distortion coefficients A_L^D represent the effect of lattice strains and may be approximated by the relation

$$A_L^D = \exp.\left[\frac{-2\pi^2 L^2 \langle \epsilon_L^2 \rangle}{d^2}\right] \qquad (2)$$

where $\langle \epsilon_L^2 \rangle$ is the mean square strain at a distance L normal to the diffracting planes of spacing d. Thus the intercept of a plot of $ln A_L$ against $1/d^2$ for different orders of the same reflection gives A_L^P directly, while the negative initial slope is equal to $2\Pi^2 L^2 \langle \epsilon_L \rangle^2$. Since tungsten is elastically isotropic, data for all reflections can be used for obtaining a plot of $ln A_L$ *vs.* $1/d.^2$ Figure 1 shows the plots of A_L^P *vs.* L for the cold-worked and partially annealed tungsten samples. The values of domain size $\bar{D}$ found from the intercept of the initial slope of the A^P curve onto L axis are

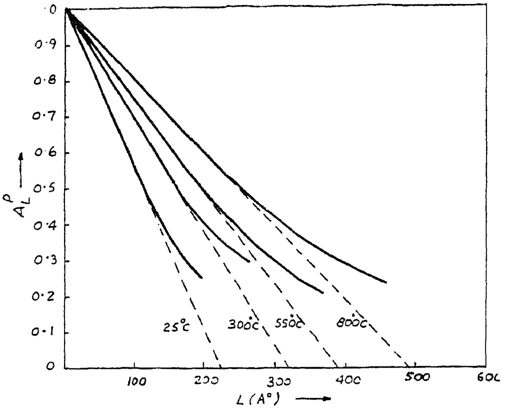


FIG. 1. Plots of particle size coefficients (A_L^P) *versus* distance in Ångstroms (L) for cold-worked and partially annealed tungsten filings.

listed in Table I. Figure 2 shows the variation of the rms strain $\langle\epsilon_L^2\rangle^{\frac{1}{2}}$ with L. Values of $[\langle\epsilon_L^2\rangle^{\frac{1}{2}}]^{\bar{D}}$, averaged over the entire domain length (from L = 20 Å to $\bar{D}$) are also given in Table I.

TABLE I

Results of Fourier analysis of X-ray line broadening in tungsten filings

Temperature °C	Domain size $\bar{D}$ Å	Strain $[\langle\epsilon^2\rangle^{\frac{1}{2}}]^{\bar{D}}$ ×10³	Dislocation density data				Flow stress τ psi
			$\rho_D \times 10^{-11}$	$\rho_\epsilon \times 10^{-11}$	ρ_D/ρ_ϵ	$\rho_t \times 10^{-11}$	
30	225	2·70	5·93	1·84	3·22	3·31	104000
300	320	1·90	2·93	0·97	3·02	1·68	75800
550	390	1·56	1·97	0·62	3·18	1·10	59160
800	490	1·21	1·30	0·39	3·33	0·69	46000

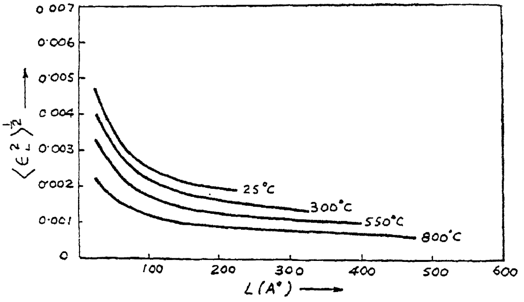


FIG. 2. Plots of rms strain ($\langle\epsilon_L^2\rangle^{\frac{1}{2}}$) *versus* distance in Ångstroms (L) for cold-worked and partially annealed tungsten filings.

DISCUSSION

Williamson and Smallman[4] have shown that it is possible to obtain two estimates of dislocation density from X-ray line broadening measurements. The contribution to dislocation density ρ_D by domain size is given by

$$\rho_D = \frac{3}{D^2} \qquad (3)$$

The dislocation density can also be computed from the rms strain using the following relationship

$$\rho_\epsilon = \frac{k\,[\langle\epsilon_L^2\rangle]^{\bar{D}}}{b^2} \qquad (4)$$

where b is the Burgers vector and k is a parameter of the order of 20. The true dislocation density is generally evaluated as

$$\rho_t = [\rho_D \rho_\epsilon]^{\frac{1}{2}} \qquad (5)$$

Values of ρ_D, ρ_ϵ, ρ_D/ρ_ϵ and ρ_t are also listed in Table I.

It is obvious from the data in Table I that the dislocation density (ρ_t) in tungsten filings is reduced on annealing at 300° C to nearly half the value at 30° C. Although Koo[5] and Schultz[6] attributed the recovery of electrical resistivity at annealing temperatures below 400° C to annealing out of single vacancies with an activation energy of 1·7 eV and above 400° C to the annihilation and rearrangement of dislocations, the present X-ray findings show without doubt that annihilation and rearrangement of dislocations take place to a considerable extent even at as low a temperature as 300° C in this metal with the highest melting point (3,410° C). Rearrangement of dislocations at 400° C has been observed[7] by electron microscopy and X-ray topography, which supports our present findings. Our X-ray results are also consistent with the fact that in tungsten dislocations along (110) planes are not extended, so that the screw dislocations can glide out of their original slip planes for annihilation and rearrangement without requiring a high activation energy. Similarly, the climb of edge dislocations is also expected to occur readily in tungsten.

The ratio ρ_D/ρ_ϵ remains nearly the same for cold-worked and partially annealed samples (Table I), thus suggesting that with increase in temperature the dislocation density (ρ_t) decreases, but the distribution of dislocations remains perhaps the same as in the fresh filings at room temperature, since small domain size and strain are a manifestation of the number and distribution of dislocations in a deformed metal.

We have recently found[8] in case of deformed filings of several HCP metals that the flow stress values calculated from dislocation densities obtained by similar X-ray analysis are approximately equal to the yield strengths of the well-annealed metals. The values of flow stress (τ) in cold-worked and partially annealed filings of tungsten calculated in the same way from the relation

$$\tau = 0 \cdot 3\ bG\ (\rho_t)^{\frac{1}{2}} \qquad (6)$$

(where G is the shear modulus) are listed in Table I. The top curve of Fig. 3 shows the variation of τ with temperature.

The yield stress (YS) in tungsten has been found to be markedly sensitive to the strain rate. For example, increase in strain rate from about 10^{-5}sec^{-1} to about 10^{-2}sec^{-1} raises the YS by a factor of 3 (Betchold[9]). When extrapolated to a strain rate of 10^{-1}sec^{-1} the YS is approximately 80,000 psi at 250° C, which is in good agreement with our extrapolated value of τ at 250° C (Fig. 3). Thus, it may be concluded that the flow stress in drastically deformed tungsten (filings) calculated from equation (6) is approximately equal to its yield strength measured with a very high strain rate ($\sim 10^{-1}$sec^{-1}).

Also shown in Fig. 3 are the values of flow stress for tungsten as a function of temperature for different strains at a constant rate of extension ($2 \cdot 8 \times 10^{-4}$sec^{-1}) from the data of Betchold and Shewman.[10] Filing is a drastic form of deformation both in terms of strain and strain rate, thus τ (for filings) can be considered to represent the flow stress for an extremely high strain value. This is supported by the results shown in Fig. 3, since the plot of τ *vs.* temperature as per our X-ray data lies above the curve for flow stress *vs.* temperature at the highest strain ($\delta = 0 \cdot 05$). If we plot the flow stress values against natural strain (δ) from Fig. 3, our values are found to approximate to flow stress values extrapolated for $\delta = 0 \cdot 1$.

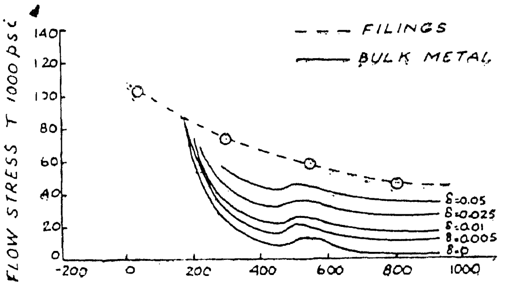


FIG. 3. Effect of temperature on flow stress of (*a*) cold worked and partially annealed tungsten filings (present work) and (*b*) annealed tungsten with different strain at the constant extension rate of $2 \cdot 8 \times 10^{-4}$sec^{-1} (from the data of Betchold and Shewman).

ACKNOWLEDGEMENTS

The authors are grateful to Dr. P. Rama Rao, Reader and Dr. S. Lele, Senior Research Fellow, for useful discussions.

1. Sato, S., *Japan J. Appl. Phys.*, 1962, **23**, 805.
2. Stokes, A. R., *Proc. Phys. Soc.*, 1948, **61**, 382.
3. Warren, B. E., *Progr. Metal Phys.*, 1959, **8**, 147.
4. Williamson, G. K. and Smallman, R. E., *Phil. Mag.*, 1956, **1**, 39.
5. Koo, R. C., *Reactive Metals* (edited by Clough, R. W.), Interscience Publishers, New York, 1959, p. 265.
6. Schultz, H., *Z. Naturforsch.*, 1959, **14**, 361.
7. Koo, R. C., *J. Less-Common Metals*, 1961, **3**, 412.
8. Gupta, R. K. and Anantharaman, T. R., Communicated to *J. Less-Common Metals*.
9. Betchold, J. H., *Trans. TMS-AIME*, 1956, **206**, 142.
10. — and Shewman, P. G., *ASM Trans.*, 1954, **46**, 397.

E.S.R. STUDIES ON GLYCINE COMPLEXES OF MANGANESE CHLORIDE AND MANGANESE BROMIDE

B. ANJANEYA SASTRY AND G. SIVARAMA SASTRY
Physics Department, Osmania University, Hyderabad-7

DIGLYCINE Manganese Chloride dihydrate $(NH_2CH_2COOH)_2.MnCl_2.2H_2O$ (hereafter referred to as G_2MCD), is one of the very few paramagnetic substances showing ferroelectric nature at room temperature. Pepinsky *et al.*[1] studied the dielectric properties of this crystal from 345° K to 77° K. Beyond 328° K, it loses its water of hydration. In the above range of temperature, they could not find the Curie temperature, Θ. E.S.R. studies on this compound have been taken up by us with a view to estimate the Curie temperature and the exchange energy (J). The corresponding manganese bromide complex of glycine which is a non-ferroelectric substance, namely, Diglycine Manganese bromide trihydrate (referred to as G_2MBT) was also taken up for study, for comparison.

The crystals of G_2MCD and G_2MBT were prepared by the method of evaporation from aqueous solutions containing two molecular weights of glycine and one molecular weight of the corresponding manganese compound. The formation of the above compounds was confirmed by measuring their density and water of hydration. In the case of G_2MCD the unit cell dimensions were checked by preliminary X-ray data. In Table I are shown the data for the two crystals.

TABLE I

Substance	*a*	*b*	*c*	*β*	Density (ρ)	Space group	Molecular weight (M)	No. of molecules in the unit cell
D_2MCD ..	9·96	8·53	6·86	107°	1·875	P_{21}	315	2
D_2MBT ..	11·10	6·12	9·65	91°	2·23	$P_{21/c}$	416	2

The first derivative of the E.S.R. signals of the above crystals and their powders were recorded with an E.S.R. spectrometer assembled in this laboratory, having 100 KHz magnetic field modulation arrangement. The details of the spectrometer are given elsewhere.[2] The cavity used was a H_{012} metallic cavity and the modulation loop was arranged at the central hole of the cavity. The substance was placed in a small glass tube and introduced in the cavity at its centre.

Anderson and Weiss[3] have calculated the isotropically narrowed line widths of undiluted paramagnetic substances assuming a simple cubic lattice. The formula for line widths as corrected by Locher and Gorter[4] is given by

$$\Delta H_{\frac{1}{2}} = 2\left[\frac{10}{3}\cdot\frac{H_p{}^2}{H_e}\right] \tag{1}$$

where H_p and H_e are the dipolar and exchange interactions given by

$$H_p{}^2 = 5\cdot1\left[g\beta\frac{N\rho}{M}\right]^2 S\,(S+1) \tag{2}$$

$$H_e = [2\cdot83\ S\,(S+1)]^{\frac{1}{2}}\,\frac{2J}{g\beta} \tag{3}$$

g is the spectroscopic splitting factor, β is the Bohr magneton, N is the Avogadro number, ρ is the density of the crystal, M is the molecular weight, S is the spin quantum number and J is the exchange integral. The Curie temperature (Θ) is obtained by the formula

$$3K\,\Theta = 2JZ\,S\,(S+1) \tag{4}$$

where K is the Boltzmann constant and Z is the number of the nearest neighbours taken to be 6.

This theory can be applied to the powders in the case of Mn^{2+} and Fe^{3+} compounds where anisotropy broadening is small. Kumugai *et al.*[5] compiled the line widths for a number of Mn^{2+} and Fe^{3+} compounds taken in the powder form only. In the present experiment, the first derivative signals of the E.S.R. spectra on the powders of G_2MCD and G_2MBT were recorded. From the above signals, the peak to peak value of the line widths (ΔH_{pp}) for the above compounds are found to be 485 Oersteds and 112 Oersteds respectively. Assuming the line shapes to be Lorentzian, the full line widths at half power points are calculated from the formula

$$\frac{\sqrt{3}}{2}\,\Delta H_{pp} = \Delta H_{\frac{1}{2}}. \tag{5}$$

The g values of the two complexes are the same having a value of 2·04.

Using the formulae from (1) to (5) the values of $\Delta H_{\frac{1}{2}}$, H, H_e, J and Θ are calculated and are given in Table II.

TABLE II

Substance	$\Delta H_{\frac{1}{2}}$	H_p in oersteds	H_e in oersteds	J in cm^{-1}	Curie temp. (Θ), in °K.
D_2MCD ..	420	454	3272	0·03439	1·734
D_2MBT ..	97	408	11450	0·1088	5·522

The value of J for G_2MCD is comparable with the values for other managanese compounds reported in the literature, while that of G_2MBT is very much larger. Moreover, the line width of G_2MBT is abnormally small. From the above result it can be concluded that the distance between neighbouring paramagnetic ions in D_2MBT may be much smaller than for the other maganese compounds, resulting in a larger exchange interaction energy. This can be confirmed when a complete X-ray analysis of the crystal is undertaken. Further work on the line width variation with temperature on single crystals of these two compounds is in progress.

The authors wish to thank Prof. K. S. Iyengar for his help and encouragement. One of the authors (BAS) is grateful to C.S.I.R., for financial assistance.

---

1. Pepinsky, R., Vedam, K. and Okaya, Y., *Phys. Rev.*, 1958, **110**, 1309.
2. Anjaneya Sastry, B. and Sivarama Sastry, G., *Physica*, 1971, (under publication).
3. Anderson, P. W. and Weiss, P. R., *Rev. Mod. Phys.*, 1953, **25**, 269.
4. Locher, P. R. and Gorter, C. J., *Physica*, 1962, **28**, 797.
5. Kumugai, H., Ono, K. and Hayashi, I., *Phys. Rev.*, 1952, **85**, 925.

INDUCED APHID RESISTANCE IN *BRASSICA JUNCEA* COSS.

D. SRINIVASACHAR AND P. K. VERMA

Division of Genetics, Indian Agricultural Research Institute, New Delhi

ABSTRACT

In two commercial varieties of *Brassica juncea*, Laha 101 and R.L. 18, treated with different concentrations of the mutagens, ethylmethane sulphonate (EMS), maleic hydrazide (MH), ethylene imine (EI), diethyl sulphate (DES) and different dozes of gamma-rays, several plants highly resistant to the attacks of the aphids, *Lipaphis pseudobrassicae* (Davis), were isolated in the M_2 generation. The two varieties responded differently to the different mutagens, EMS and gamma-rays inducing more aphid resistant mutations in Laha 101 and HA and EI in R.L. 18. As aphid resistance may not be a case of simple inheritance effective control over the pest could be achieved by concentrating the resistant genes in a single strain.

INTRODUCTION

An important part of any project of insect control is the search for the sources of resistance and utilize them in reducing the population of insects and the damage done by them. If the resistance genes are found in distantly related species and genera the problems of crossability, hybrid inviability and linkage of undesirable characters, usually accompanying distant hybridization, may render exploitation of such genes almost impossible. One is, therefore, faced with the problem of looking for resistance within the limits of the species. Where naturally occurring resistance genes are very few or not yet discovered within the parameters of a species, artificial induction of mutations for such characters assumes importance. However, at the present status of our knowledge the chances of getting such mutations cannot be predicted.

Of the three species of aphids, the cabbage aphid (*Brevicoryne brassicae* L.), the green peach aphid (*Myzus persicae* Sulz.) and the false cabbage aphid [*Lipaphis pseudobrassicae* (Davis)], known to attack the plants of the cabbage family, the last one is important in India as it is known to have completely wiped out the oleiferous *Brassica* crop in years of severe infestation. Besides directly devastating the plants the aphids also act as vectors to virus diseases.[4] In an aphis resistant rape (*B. napus* L.)[5] developed by crossing a swede hybrid (Calder × Superlative) with club root resistant rape the gene for resistance to cabbage aphid came from the Calder swede. There was a clear difference in the rates at which the aphids increased in the resistant and susceptible varieties[3] and in trials the resistant rape gave 50% more yield.[4] It was, however, not resistant to either the green peach aphid or to the false cabbage aphid. Under artificial conditions of infestation *B. napus* was found to be resistant and *B. Tournefortii* and *Eruca sativa* tolerant to the false cabbage aphid.[6] A glossy mutant of kale (*B. oleracea* var. *acephala*) was found to be resistant to cabbage aphid.[9] It is thus seen that there are very few aphid resistant genes in the genus *Brassica*.

EXPERIMENTAL RESULTS AND CONCLUSIONS

Seeds of two commercial varieties of *B. juncea*, Laha 101 and R.L. 18 were treated with three different concentrations of the mutagens, ethylmethane sulphonate (EMS), maleic hydrazide (MH), ethylene imine (EI), and diethyl sulphate (DES) and also irradiated with three different dozes of gamma-rays. The M_2 families raised in a randomized replicated design were scored for aphid reaction under field conditions. Plants on which only a few aphids were found and which showed no apparent signs of aphid injury were rated as highly resistant, those that were inherently less damaged or less infested than the untreated controls under comparable environmental conditions as resistant and the rest as susceptible.

In the variety Laha 101 out of a total population of 2837 scored, 136 plants (4·79%) were highly resistant, 432 (15·22%) resistant and the rest susceptible to aphids. For the variety R.L. 18 in which 2,592 plants were scored the comparable figures for the highly resistant and resistant classes were 86 (3·31%) and 127 (4·89%) respectively. Thus the two varieties responded differently to the mutagenic agents. Gamma-rays and EMS were effective in inducing resistance mutations in Laha 101 whereas EI and HA were effective in R.L. 18 on which DES and gamma-rays, in the doses used, were less effective and EMS not effective at all (Table I).

Segregation ratios for the different categories of aphid reaction indicate that aphid resistance may not be a simply inherited trait but may involve a few genes. By crossing the highly resistant plants *inter se* it is possible to concentrate the resistance genes in a single strain of *B. juncea* which although not immune to the attack of aphids will nevertheless hamper the pest in such a way that other controlling mechanisms, biological and chemical, become more effective.

Factors responsible for the relative resistance of plants to aphid attack are not very well understood. Differences in the waxiness of plants occur between species of *Brassica* and may be correlated with relative susceptibility to aphids.[8] Rape and kale (*B. oleracea* var. *acephala*) having blue-green leaves are susceptible to aphids whereas turhips (*B. rapa*) having bright green leaves are resistant. Non-waxy mutants arising from a waxy kale were not found to be infested by the cabbage aphids.[9] In glossy leaved brussels sprouts (*B. oleracea* var. *gemmifera*) resistance to cabbage aphid but increased susceptibility to green peach aphid was found.[10] Waxes and related substances are present as an integral part of the cell cytoplasm as well as forming cuticular wax in varieties of *B. oleracea*.[2] Qualitative as well as quantitative differences in the cytoplasmic wax contents may be of importance in connection with aphid resistance. Varieties of *B. oleracea* and *B. napus* contain either 15-nonacosanone ($C_{29}H_{58}O$) or 15-nonacosanol, the ketone and alcohol from *n*-nonacosan. While both are present in brussels sprouts neither were identified in white mustard (*B. alba*) which is known to be fairly resistant to cabbage aphids.

Other factors, besides waxiness, may be involved in aphid resistance. The mustard oil glucoside, sinigrin, has been found to be a specific stimulus for host selection by cabbage aphid.[10] Lines of kale with some resistance to aphids but not with waxless leaves can be bred. Perhaps they have a low sinigrin content. It would appear, therefore, that although sinigrin may be a specific stimulus for selection of the host by the cabbage aphid, reaction

TABLE I

Percentage of plants, highly resistant, resistant and susceptible to the aphid, Lipaphis pseudobrassicae *in the different mutagenic treatments in the* B. juncea *varieties, Laha 101 and R.L. 18*

Treatments	Laha 101			R.L. 18		
	Highly resistant	Resistant	Susceptible	Highly resistant	Resistant	Susceptible
EMS: 0·2%	10·9	25·9	63·2	0	3·9	96·1
,, 0·4%	8·8	28·8	62·4	0	3·6	96·4
,, 0·6%	4·6	15·5	79·9	0	3·4	96·6
Total ..	8·1	23·4	68·5	0	3·6	96·4
HA: 0·05%	6·3	11·4	82·3	3·1	2·6	94·3
,, 0·10%	0	0	100·0	4·7	3·3	92·0
,, 0·15%	0	0	100·0	5·9	1·5	92·6
Total ..	2·1	3·8	94·1	4·6	2·5	92·9
EI: 0·5%	4·7	20·5	74·8	0	5·9	94·1
,, 0·10%	7·3	20·5	72·2	0	4·9	95·1
,, 0·15%	0	0	100·0	17·2	8·0	74·8
Total ..	4·0	13·7	82·3	5·7	6·3	88·0
DES: 30 min.	3·1	20·4	76·5	0	8·5	91·5
,, 60 ,,	0	0	100·0	2·8	3·9	93·3
,, 90 ,,	0	0	100·0	0	7·0	93·0
Total ..	1·0	6·8	92·2	0·9	6·5	92·6
Gamma-rays: 80 kr.	2·9	20·9	76·2	0·5	4·0	95·5
,, 100 ,,	15·0	24·4	60·6	0	5·7	94·3
,, 120 ,,	8·7	29·5	61·7	4·4	13·0	82·6
Total ..	8·9	24·9	66·2	1·6	7·6	90·8

to aphid is determined by the waxy and non-waxy nature of the *Brassica* plants. Resistance of rape to attacks by the cabbage aphid is said to have resulted from a combination of host non-preference and antibiosis.[3] Resistance to false cabbage aphid in tetraploid toria (*B. campestris* var. *toria*) is attributed to antibiosis.[7] Chromatographic analysis of several varieties of peas and the aphids infesting them showed that the varieties susceptible to pea aphid attacks contain a higher concentration of amino-acids than the resistant varieties with the exception of the amino-acid proline.[1]

We are grateful to Dr. M. S. Swaminathan, Director, I.A.R.I., for his encouragement.

---

1. Auclair, J. L. and Maltais, J. B., *Canad. Ent.*, 1950, **82**, 175.
2. Chibnall, A. C. and Piper, S. H., *Biochem. J.*, 1934, **28**, 2209.
3. Dunn, J. A. and Kempton, D. P. H., *Ann. Appl. Biol.*, 1969, **64**, 203.
4. Lamp, C. A., *Tasm. J. Agric.*, 1965, **36**, 21.
5. Palmer, T. P., *NZ. J. Agric.*, 1960, **101**, 375.
6. Shiv Raj, Singh, Narain, A., Srivastava, K. P. and Siddique, J. A., *Indian Oilseeds J.*, 1965, **9**, 215.
7. Rajan, S. S., *Ibid.*, 1961, **5**, 251.
8. Thompson, K. F., *Nature, Lond.*, 1963, **198**, 209.
9. Way, M. J. and Murdie, G., *Ann. Appl. Biol.*, 1965, **56**, 326.
10. Wensler, R. J. D., *Nature, Lond.*, 1962, **195**, 830.

ACTION OF ANTIBIOTICS AND AN IMIDAZOLE DERIVATIVE ON *DRECHSLERA PEDICELLATA*, A ROOT ROT FUNGUS

SHANKER BHAT SULLIA
Department of Botany, Bangalore University, Bangalore

ABSTRACT

The action of two antifungal antibiotics, hamycin and chainin and an imidazole derivative on *Drechslera pedicellata* (Henry) Subram. and Jain, a root rot pathogen of maize and several grasses, was studied *in vitro*. Hamycin and the imidazole derivative completely inhibited the growth of the fungus at 5·0 μg/ml concentration in potato-dextrose-agar medium. The minimum concentration of hamycin showing a growth-retarding effect was 0·01 μg/ml while that of the imidazole derivative was 0·5 μg/ml. Chainin inhibited fungal growth completely at 10 μg/ml. The minimum effective concentration was 1·0 μg/ml.

Hamycin induced remarkable morphological abnormalities in the mycelium while the other chemicals did not. Low concentrations of hamycin (0·01 μg/ml) caused nodulation of the hyphae and at higher concentrations (0·05–0·1 μg/ml) vesiculation of the mycelium occurred. This led to pronounced cell membrane damage and the lysis of hyphae resulting in leakage of intracellular contents.

INTRODUCTION

CHEMICAL control of root disease fungi has become more feasible with the present knowledge that chemicals administered through foliar sprays are translocated to roots and change the pattern of root exudation.[1,6,11] Among the chemicals used as fungicides, antibiotics are gaining increasing popularity. Antifungal antibiotics are produced by several fungi, bacteria and actinomycetes[2] and these, in the natural soil environment, play an important role in modifying the soil microflora. However, the *in vitro* activity of several of these antibiotics may be quite different from their influences *in vivo*. In addition to antibiotics, the remarkable biological properties of several derivatives of imidazole have been recently demonstrated.[8]

A fungus recently isolated from rice field soils[7] evoked considerable interest. This fungus, *Drechslera pedicellata* (Henry) Subram. & Jain, is known to cause root rot diseases in maize and several grasses.[5] It was noted that the fungus showed a high degree of resistance to the organophosphorus fungicide "kitazin" sprayed on the field for experimental purpose. It was therefore thought worthwhile studying the effect of some antifungal substances on the growth of this fungus. Two of the fungicides used here are polyene antibiotics, hamycin and chainin and the third is an imidazole derivative (N, N-diethyl-*p*-imidazol-*l*-*yl*-phenyl phosphonothionic amide). The *in vitro* activity of these chemicals is described in this paper.

EXPERIMENTAL

All the growth experiments were conducted using potato-dextrose-agar medium. Different concentrations of the chemicals were incorporated into the medium before pouring into plates to obtain the specified concentration in the final volume of the medium. Pure potato-dextrose-agar plates served as control. The effect of the chemicals on the fungus was assessed by comparing the linear growth using the linear growth rate method.

RESULTS AND DISCUSSION

The linear growth of the fungus in different concentrations of the three antifungal substances is compared in Fig. 1. The concentrations are represented on a logarithmic scale and the linear growth on a linear scale. The different chemicals were tolerated by the fungus to varying degrees. Hamycin and the imidazole derivative inhibited growth of the fungus completely at 5·0 μg/ml. However, the latter showed no growth inhibition upto a concentration of 0·5 μg/ml, whereas hamyin showed growth retarding effect even at a concentration of 0·01 μg/ml. Chainin was less effective on the fungus than the other two chemicals, requiring a higher concentration for complete growth inhibition (10·0 μg/ml). It was not growth inhibitory below a concentration of 1·0 μg/ml.

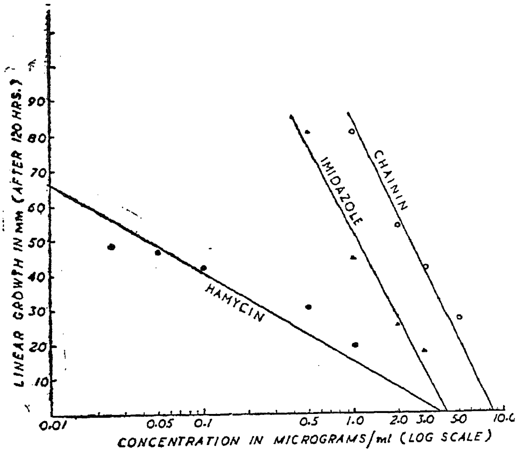


FIG. 1. Effect of different concentrations of hamycin, chainin and the imidazole derivative on the linear growth of *Drechslera pedicellata*.

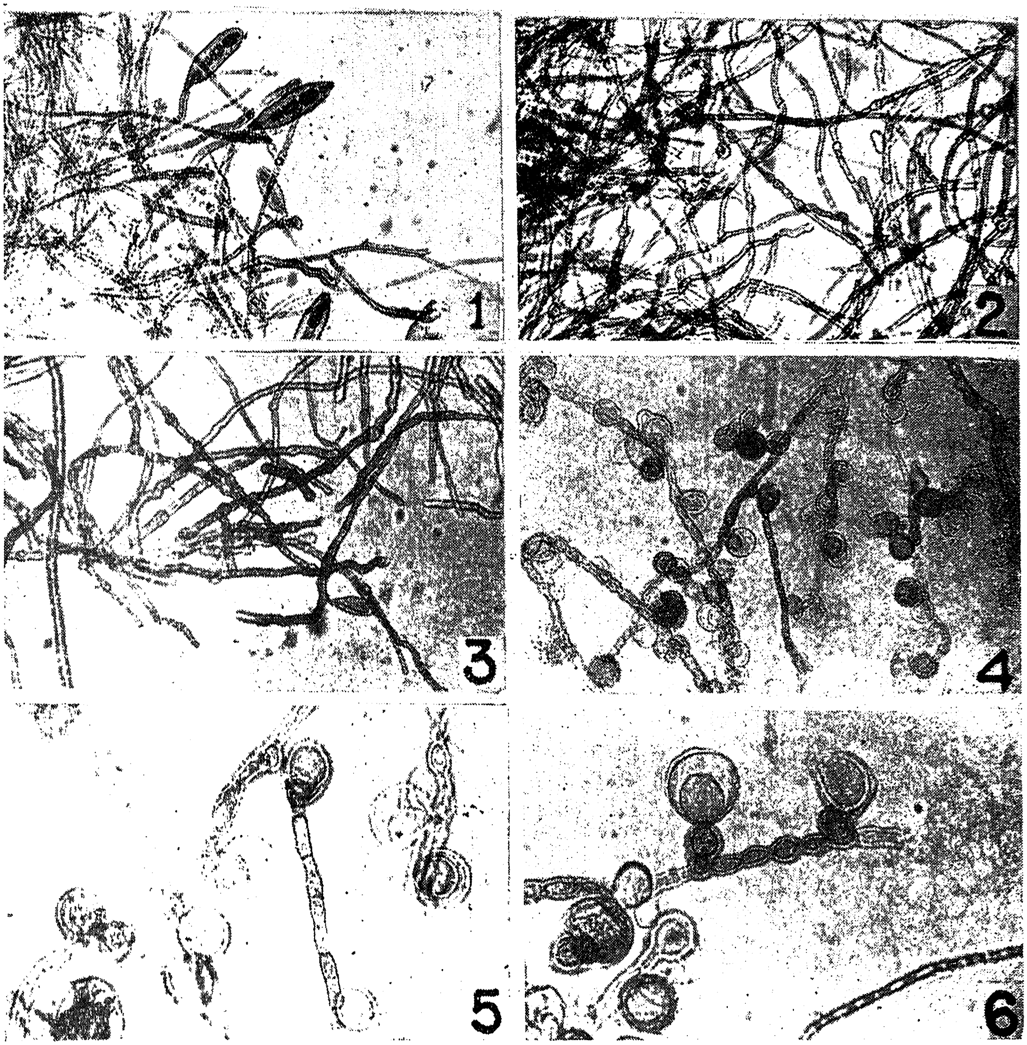
Hamycin induced remarkable morphological changes in the fungal mycelium. Low concentrations (0·01 μg/ml) induced the swelling of the hyphae at the region of the septa (Photomicrographs 2 and 3). At higher concentrations (0·5 μg/ml) vesiculation of the hyphae occurred. Globose to irregular swellings appeared scattered on the hyphae (Photomicrographs 4 and 5). The diameter of these vesicle-like structures varied from 9 to 15 μ. At 1·0 μg/ml, lysis of the hyphae at the region of the vesicles took place with the concomitant leakage of cell contents.

The rapid leakage of intracellular constituents as a result of changes in permeability or loss of structural integrity of cell membranes has been noted for several polyene antibiotics.[4] The polyenes are known to bind themselves to the sterol components of the fungal cell membrane. However, the molecular basis of the difference in action of different polyene antibiotics remains to be determined. The vesiculation of the hyphae noted here may be due to the loss of structural integrity of the cell membrane as it leads to complete lysis of the cell and not just a changed permeability.

Polyene antibiotics are not universal in their action on fungi as there are several species which are resistant to these chemicals. Several *Pythium* species are not inhibited by polyene antibiotics.[3,9,10] It is difficult to explain why the present fungus which is resistant to several other fungicides is more easily inhibited by the polyene antibiotics whereas *Pythium* which is also a soil inhabitant is resistant to similar polyene antibiotics. Another observation from the present study is that two antibiotics though both are polyenes vary greatly in their range of activity and their ability to induce morphological abnormalities on the same fungus. The growth-retarding effect of hamycin could be noted even at a concentration of 0·01 μg/ml but it required a 100-fold higher concentration of chainin to show growth inhibition, and this was not accompanied by morphological changes in the latter case.

The striking fungistatic effect of the imidazole derivative is evident from the data (Fig. 1). According to Tolkmith *et al.*,[8] this compound controlled *Erysiphe cichoracearum* on cucumber and *Phytophthora infestans* on potato plants at concentrations of 10 and 18 μg/ml respectively. However, in the present *in vitro* studies, this fungicide checked growth of the fungus completely at a much lower concentration (5·0 μg/ml). This might suggest that the concentration of the fungicide required for the control of the fungus *in vivo* may be much lower than that mentioned for *Erysiphe* or *Phytophthora*.

The low mammalian toxicity and the high fungitoxicity of the imidazole derivative and the antibiotic hamycin suggest that these



PHOTOMICROGRAPHS 1–6. Effect of antibiotic hamycin on the mycelium of *Drechslera pedicellata*. Photo 1. Untreated fungus mycelium with conidia. Photos 2–3. Swelling of hyphae at the region of the septa when treated with 0·01 μg/ml concentration of hamycin. Photos 4–5. Vesiculation of hyphae at 0·5 μg/ml hamycin Photo 6. Lysis of the vesicles to release intracellular contents at 1·0 μg/ml hamycin (Photos 1–2, × 190; Photos 3–4, × 300; Photos 5–6, × 675.)

could be of therapeutic value in cases of root rot caused by the fungus.

ACKNOWLEDGMENTS

The author is thankful to Prof. M. Nagaraj, Professor and Head of the Department of Botany, Bangalore University, for laboratory facilities and encouragement. Thanks are due to Prof. T. S. Sadasivan, Director, University Botany Laboratory, Madras 5, for suggesting the work, which was begun at Madras. Grateful thanks are due to Dr. Tolkmith for sending a sample of imidazole derivative.

1. Balasubramanian, A. and Rangaswamy G., *Plant and Soil*, 1969, **30**, 210.
2. Dekker, J., *Ann. Rev. Microbiol.*, **1963**, **17**, 213.
3. Hendrix, J. W. and Lauder, D. I., *J. Gen. Microbiol.*, 1966 **44**, 115.
4. Newton, B. A., *A. Rev. Microbiol.*, 1965, **19**, **209**.
5. Shepherd, R. J., Butler, E. E. and Hall, D. H., *Phytopathology*, 1967, **57**, 52.
6. Slankis, V., Reneckles, V. C. and Krotokov, G., *Physiol. Plant.*, 1964, **17**, 301.
7. Sullia, S. B., *Proc. Indian Acad. Sci.*, 1969, **69**, 295
8. Tolkmith, H., Seiber, J. N. and Budde, P. B., *Science*, 1967 **158**, 1462.
9. Vaartaja, O., *Phytopathology*, 1960, **50**, 870.
10. — and Agnihotri, V. P., *Plant and Soil*, 1969, **30**, 49.
11. Vrany, J., Vancura, V. and Macura, J., *Folia Microbiol.*, 1962, **7**, 61.

LETTERS TO THE EDITOR

DISSOCIATION ENERGY, r-CENTROIDS AND FRANK-CONDON FACTORS OF BiO MOLECULE

THE potential energy curves, r-centroids and Franck-Condon factors for the bands of the A–X system of the BiO molecule are determined. The necessary molecular constants required are taken from Barrow, Gissane and Richards.[1]

The study of potential energy curves, r-centroids and Franck-Condon factors is of fundamental importance in chemical physics for the understanding of various physical problems arising in astrophysics, gas kinetics and aerodynamics. The present study has been taken up with this wider aim in view. This study is also of interest since the rotational lines for the bands of the A–X system are found to exhibit abnormal width[2,3] on account of unresolved hyperfine structure. This has been attributed to the large magnetic moment of the Bismuth atom ($\mu_I = 4 \cdot 39$ n.m.).

THE TRUE POTENTIAL ENERGY CURVES

The present paper deals with the construction of potential energy curves for $A^2\Pi_{\frac{1}{2}}$–$X^2\Pi_{\frac{1}{2}}$ states of BiO molecule using the well-known RKRV[4,5] method.

The turning points for five vibrational energy levels of the $X^2\Pi_{\frac{1}{2}}$ state and seven vibrational energy levels of the $A^2\Pi_{\frac{1}{2}}$ state have been calculated and presented in Table I.

TABLE I

Potential energy curves for different states of BiO molecule

v	$U+T_e$ (cm^{-1})	$r_{\text{min.}}$(Å)	$r_{\text{max.}}$ (Å)
	$T_e=0$	$X^2\Pi_{\frac{1}{2}}$ state	
0	346·5	1·879	1·993
1	1030·0	1·844	2·044
2	1702·0	1·819	2·079
3	2370·5	1·801	2·110
4	3029·5	1·785	2·139
	$T_e=14187 \cdot 4$	$A^2\Pi_{\frac{1}{2}}$ state	
0	14440·7	2·075	2·209
1	14944·3	2·037	2·270
2	15442·0	2·010	2·312
3	15934·1	1·986	2·345
4	16420·7	1·968	2·377
5	16901·7	1·954	2·408
6	17377·1	1·940	2·437

The true potential energy curves
molecular electronic state have been u
estimate the dissociation energies of di
molecules in a number of cases[6] by fitti
empirical potential energy curve to th
potential energy curve. The Lippincott
parameter function has been found to
suitable function for this purpose in a
number of diatomic molecules. In the p
case using this three-parameter Lip
function the dissociation energies calcula
the ground $X^2\Pi_{\frac{1}{2}}$ and upper $A^2\Pi_{\frac{1}{2}}$ stat
21300 cm^{-1}(2·641 ev) and 18500 cm^{-1}(2·29
respectively. With these values the di
tion products in the upper and lower
are determined as follows:

Since $T_e + D_e'(A^2\Pi_{\frac{1}{2}}) = D_e''(X^2\Pi_{\frac{1}{2}}) +$ A
excitation energy, the atomic excitation
is $14{,}187 \cdot 4 + 18{,}500 - 21{,}300 = 11{,}387 \cdot 4$ cm.
is in very good agreement with the a
excitation of Bi ($^2D_{3/2}$) 11419 cm.$^{-1}$ Th
BiO molecule gets dissociated in the upp
lower states as

Bi ($^2D_{3/2}$) + O($^3P_2$) in the upper
and Bi ($^4S_{3/2}$) + O($^3P_2$) in the lower

r-CENTROIDS AND FRANCK-CONDON FACT

The r-centroids and Franck-Condon f
for the bands of $A^2\Pi_{\frac{1}{2}}$–$X^2\Pi_{\frac{1}{2}}$ system o
were determined by Nicholls and Jarmain
Fraser and Jarmain[8] methods are present
Table II.

In the present case the Morse potenti
found to be a very good approximation f
lower portion of the potential curves.
Graphical and Quadratic equation m
have been used for the evaluation of r-cen
for the bands of $A^2\Pi_{\frac{1}{2}}$–$X^2\Pi_{\frac{1}{2}}$ system of
molecule. The results are presente
Table II. A smooth curve has been ob
when a graph was drawn between $\bar{r}_{v',}$
$\lambda_{v',v''}$ (the wavelength of the corresp
transition) as has been observed by Ni
and Jarmain for r_{e1} less than r_{e2}. The seq
difference $\Delta \bar{r} = \bar{r}_{v'+1,\, v''+1} - \bar{r}_{v',\, v''}$ for
system is found to be a constant and les
0·01 Å indicating thereby the potential
not wide.

The Franck-Condon factors for the ban
$A^2\Pi_{\frac{1}{2}}$–$X^2\Pi_{\frac{1}{2}}$ system of BiO molecule are d
mined by the r_e-shift method of Fraser
Jarmain and presented in Table II.

TABLE II

r-centroids and Franck-Condon factors of $A^2\Pi_{\frac{1}{2}}$-$X^2\Pi_{\frac{1}{2}}$ *system of BiO*

v' \ v''		0	1	2	3	4
0	(*a*)	2·036	2·057	2·078	2·097	2·117
	(*b*)	2·036	2·057	2·078	2·100	2·120
	(*c*)	0·003	0·022	0·075	0·146	0·204
1	(*a*)	2·020	2·041	2·062	2·082	2·102
	(*b*)	2·020	2·041	2·062	2·082	2·105
	(*c*)	0·014	0·070	0·137	0·132	0·047
2	(*a*)	2·005	2·026	2·047	2·067	2·087
	(*b*)	2·005	2·025	2·046	2·067	2·088
	(*c*)	0·035	0·112	0·113	0·026	0·022
3	(*a*)	1·990	2·011	2·032	2·052	2·073
	(*b*)	1·988	2·010	2·030	2·051	..
	(*c*)	0·062	0·120	0·044	0·019	..
4	(*a*)	1·976	1·996	2·017	2·037	2·057
	(*b*)	1·973	1·993	2·015	2·035	2·056
	(*c*)	0·087	0·093	0·001	..	..
5	(*a*)	1·961	1·982	2·002	2·023	2·043
	(*b*)	1·957	1·979	1·998	2·020	2·040
	(*c*)	0·106	0·056	..	..	..

$\bar{r}_{v,v''}$ values in Å (*a*) Graphical method, (*b* Quadratic equation method, (*c*) Franck-Condon factors.

intensity distribution for this system is in accordance with the Franck-Condon principle.

The authors wish to express their thanks to Prof. J. Bhimasenachar for his interest and encouragement. One of the authors (T. V. R. K. R.) is grateful to UGC for financial assistance.

Spectroscopic Laboratories,
Department of Physics,
S.V. University, Tirupati, (A.P.),
February 26, 1971.

T. V. RAMAKRISHNA RAO.
S. V. J. LAKSHMAN.

1. Barrow, R. F., Gissane, W. G. M. and Richards, D., *Proc. Roy. Soc.*, 1967, **300 A**, 469.
2. Gissane, W. G. M. and Barrow, R. F., *Proc. Phys. Soc.*, 1965, **85**, 1048.
3. Atkins, P. W., *Proc. Roy. Soc.*, 1967, **300 A**, 487.
4. Vanderslice, J. T., Mason, E. A., Maisch, W. G. and Lippincott., E. R., *J. Mole. Spectr.*, 1959, **3**, 17.
5. —, —, — and —, *Ibid.*, 1960, **5**, 83.
6. Steele, D., Lippincott, E. R. and Vanderslice, J. T., *Rev. Mod. Phys.*, 1962, **34**, 239.
7. Nicholls, R. W. and Jarmain, W. R., *Proc. Phys. Soc.*, 1956, **69**, 253.
8. Jarmain, W. R. and Fraser, P. A., *Ibid.*, 1953, **66 A**, 1153.

NEW ELECTRONIC TRANSITIONS IN DIATOMIC SrBr MOLECULE

THE band spectrum of diatomic strontium bromide molecule as studied by earlier workers[1-5] consists of five discrete systems of bands. These are associated with transitions from various excited states $A^2\Pi$, $B^2\Sigma$, $C^2\Pi$, $D^2\Sigma$ and $E^2\Sigma$ to the ground $X^2\Sigma$ state. Band systems associated with transitions between the excited states are observed in the spectra of SrCl[6] and in some of the related molecules like CaCl,[7] CaBr,[8] BeF,[9] and MgCl.[10] It is, therefore, thought worthwhile to re-investigate the spectrum of the SrBr molecule with a view to search for possible analogous transitions.

In the present investigation, an anhydrous specpure sample of $SrBr_2$ is spread uniformly in a quartz tube with a central capillary of about 5 mm in diameter and 30 mm in length and a steady stream of argon is kept flowing over the substance. The power of excitation is supplied from a high frequency (40 MHz) high power (500 watts) oscillator. With constant external heating, a characteristic intense scarlet discharge is maintained and photographed using a Hilger three-prism glass Littrow spectrograph with a dispersion of about 23 Å mm⁻¹ at 5300 Å.

In addition to the previously known systems of bands, the spectrum of SrBr in the present investigation exhibits a number of bands degraded to shorter wavelengths in the visible region (λλ 5800–5000 Å). These bands are analysed as belonging to six sub-systems, associated with transitions between various excited states. The bands in the region λλ 5800–5400 Å could be analysed on the basis of two components of a $^2\Pi$–$^2\Sigma$ transition, the lower state of which is identified as the second excited $B^2\Sigma$ state. The upper state, with a doublet splitting of 83 cm^{-1} is identified as $F^2\Pi$ state by analogy with the SrCl molecule. Another system of bands arising from the newly identified $F^2\Pi$ state to the lower $A^2\Pi$ state is identified and analysed in the region λλ 5600–5200 Å. The bands on the shorter wavelength side of this system in the region λλ 5300–5000 Å are analysed into two overlapping systems with a common lower state, identified as the $A^2\Pi$ state. The upper states of these two systems are identified as $G^2\Delta$ and $H^2\Sigma$, by analogy with the SrCl molecule. Figure 1 is a reproduction of the new systems of bands showing the vibrational assignments for some of the prominent band heads. The vibrational constants of the

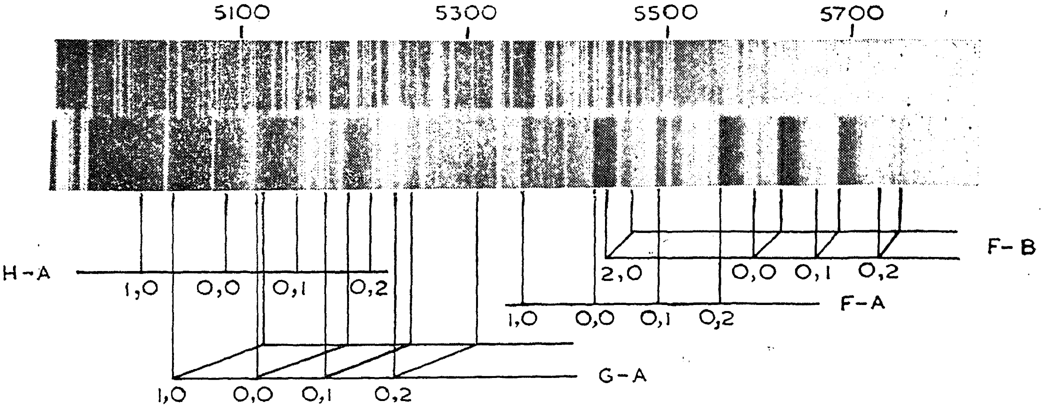


FIG. 1. New electronic transitions in SrBr molecule.

various excited states of the SrBr molecule observed in the present investigation are summarised in Table I.

TABLE I

New electronic transitions of the SrBr molecule

Transition		$\nu_{(0,0)}$ (cm^{-1})	ω_e' (cm^{-1})	Doublet splitting (cm^{-1})
$F^2\Pi_{1/2}-B^2\Sigma$	..	17779·7	256·7	83 ($F^2\Pi$)
$F^2\Pi_{3/2}-B^2\Sigma$	..	17863·0		
$F^2\Pi_{1/2}-A^2\Pi_{1/2}$	..	18434·0		
$G^2\Delta_{5/2}-A^2\Pi_{3/2}$	..	19282·1	256·6	26 ($G^2\Delta$)
$G^2\Delta_{3/2}-A^2\Pi_{1/2}$	..	19557·6		
$H^2\Sigma-A^2\Pi_{1/2}$	..	19658·3	267·7	

Spectroscopy Res. Lab., B. R. K. REDDY.
Department of Y. P. REDDY.
Physics, (MISS) ASHRAFUNNISA.
Andhra University, P. TIRUVENGANNA RAO.
Waltair, (A.P.), *March* 6, 1971.

---

1. Olmsted, C. M., *Z. Wiss. Photogr.*, 1906, **4**, 255.
2. Walters, O. H. and Barratt, S, *Proc. Roy. Soc.*, 1928, **118**, 120.
3. Hedfeld, K., *Z. Phys.*, 1931, **68**, 610.
4. Harrington, R. E., *New Band Systems of the Diatomic Earth Halides.* Dissertation, University of California, 1942.
5. Reddy, Y. P. and Rao, P. T., *Ind. J. Pure and Appl. Phys.*, 1966, **4**, 251.
6. Novikov, M. M. and Gurvich, L. V., *Optics and Spectroscopy*, 1965, **19**, 76.
7. Schutte, M., *Z. Naturforsch, A*, 1954, **9**, 891.
8. Reddy, B. R. K., Reddy, Y. P. and Rao, P. T. *Curr. Sci*, 1970, **39**, 485.
9. Rao, K. M. and Rao, P. T., *Ind. J. Pure and Appl. Phys.*, 1965, **3**, 177.
10. Rao, V. S. and Rao, P. T., *Ind. J. Phys.*, 1963, **37**, 640.

KINETICS OF DEHYDRATION OF *t*-BUTANOL BY GAS CHROMATOGRAPHY

IN solid-gas chromatography, when the adsorbate pulse passing through the column containing the adsorbent undergoes a reaction, a distortion in the elution chromatographic peak will be observed. In some cases where the reaction rate is fast and the column is long, the products formed may be completely separated from the reactants. Gas chromatography has been extensively employed in the evaluation of kinetic parameters of many heterogeneous reactions[1] and a few liquid phase homogeneous reactions.[2] The rate constants obtained by the chromatographic reactor method agree with those obtained by the conventional methods.[3] For the evaluation of the rate constants by the inert reference substance method,[1] the areas of the reactant and inert are compared. From the distortions in the elution chromatographic peaks,[4] the orders and the rate constants for the reactions occurring on the chromatographic column can also be calculated. The main advantage of the chromatographic method is that one can always calculate[5] the true energy of activation (E_{surface}) for the reaction as against the apparent energy of activation ($E_{\text{app.}}$) obtained, in general, by other conventional methods. In the present work, the dehydration of tert. butylalcohol (TBA) on silica gel has been studied by the chromatographic method.

When pulses of pure TBA were introduced into the column containing silica gel (BDH, AR grade), using hydrogen as the carrier gas, the alcohol underwent dehydration above 180° C. The gas chromatograph employed in the present work was fabricated locally as described by Miller.[6] The column was first activated by flushing with hydrogen at a flow rate of 80 ml/min for 6 hrs at 230° C. The surface area of the silica gel sample (BET, N_2, −196° C) was found to be 377 m^2/g and the total pore volume was 0·534 cc/g.

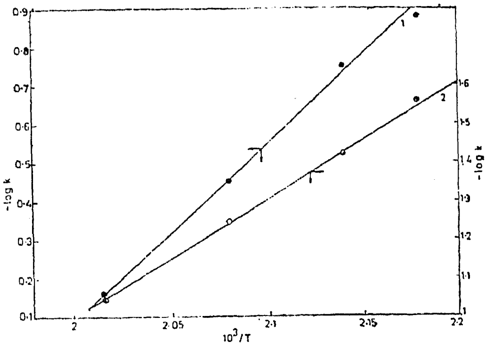


FIG. 1. Arrhenius plots for the dehydration of *t*-butanol. 1. $E_{surface}$—Phillips *et al.*[5] method. 2. E_{app}—From the distortion in the elution chromatographic peaks.

The mathematical model for an irreversible first order reaction[4] was assumed for the dehydration process. When the specific retention volumes were corrected for the pressure gradient, the plots of log S_x *vs* V $[=(V_x - V_b)/(V_a - V_b)]$, obtained from the distorted elution peaks, were found to be straight lines indicating the correctness of the assumption. Here V_a and V_b denote the specific retention volumes of TBA and water respectively. V_x is the specific retention volume at any point x on the chromatogram between the two peak maxima and S_x is the magnitude of the signal at any point x. It has been observed that one of the products (propylene) formed during the reaction does not produce any separate signal $[A \rightarrow B + (C)]$. Hence, the model proposed by Phillips *et al.*[5] for this type of reaction has also been made use of in the evaluation of the first order rate constants by the pulse method.

From the corresponding Arrhenius plots (Fig. 1) the energy of activation (E_a) by the two methods has been evaluated. It is observed that E_a calculated from the distortion in the peak has a value 14·11 kcals/mole and the corresponding value obtained by the method of Phillips *et al.* is 21·2 kcal/mole. This is only to be expected since in the latter method the E_a value obtained is for the surface reaction ($E_{surface}$) whereas the $E_{app.}$ for the dehydration process is obtained by the former method. The values of $E_{surface}$ and $E_{app.}$ would differ from each other in magnitude by the heat of adsorption of the adsorbate. Hence, to check the accuracy of the values obtained by the two methods, the heat of adsorption of TBA was calculated from the log V_g *vs.* 1/T plot and was found to be 7·4 kcals/mole. This agrees well with the difference (7·09 kcals/mole) in the E_a values obtained in the present instance, thus indicating the advantage of using solid-gas chromatography for the rapid and accurate evaluation of kinetic parameters of heterogeneous reactions.

Dept. of Chemistry,
Indian Institute of
Technology,
Madras-36, India,
February 5, 1971.

P. RAJARAM.
B. VISWANATHAN.
M. V. C. SASTRI.
V. SRINIVASAN.

---

1. Langer, S. H., Pattern, J. E. and Yurchak, J. Y., *Ind. Eng. Chem.*, 1969, **61** (4), 10.
2. — and Purnell, J. H., *J. Phys. Chem.*, 1963, **67**, 263.
3. — and Pratt, G. L., *Ibid.*, 1969, **73**, 2095.
4. Van Swaay, M., In *Advances in Chromatography*, Ed. by Giddings, J. C. and Kellers, R. A., Marcel Dekker, New York, 1969, 8, 363.
5. Phillips, C. S. G., Hart-Davis, A. J., Saul, R. G. L. and Wormald, J., *J. Gas Chromatogr.*, 1967, **5**, 424.
6. Miller, J. M., In *Experimental Gas Chromatography*, by Gow Mac Instrument Company, New Jersey, 1965.

STUDIES IN THE RELATIONSHIP BETWEEN BETAFITE AND PYROCHLORE

LITERATURE survey revealed that the relationship between betafite and pyrochlore has not been clearly established.[1-4] Hogarth[4] has not classified betafite as a mineral with pyrochlore structure containing 15% or more, uranium.

In the present studies synthetic betafite has been prepared by introducing 15% uranium in $Y_2Ti_2O_7$ (pyrochlore). The procedure adopted in the preparation of the samples is the same as in the previous communication,[5] except that the samples were quenched. The diffractometer patterns were taken by using CuKα radiation filtered through nickel.

The results are given in Table I.

It is seen from Table I that in the composition A, synthetic betafite consists of two phases pyrochlore as major phase and brannerite as minor phase. This agrees well with the mineral betafite reported by Gasperin,[3]

TABLE I

Composition (wt.%)					Phases present
	Y_2O_3	CaO	U_3O_8	TiO_2	
A	43·56	..	15	41·44	Betafite (pyrochlore + brannerite) (a=10·02 Å)
B	40·56	3	15	41·44	Betafite (pyrochlore + brannerite trace) (a=10·03 Å)
C	34·56	9	15	41·44	Pyrochlore (a=10·05 Å)
D	28·56	15	15	41·44	Pyrochlore (a=10·09 Å) + perovskite

On introducing 3% of Ca^{2} ions in the betafite (composition B) the intensity of the brannerite phase decreased and the lattice constant of the pyrochlore phase increased to 10·03 Å. This is due to the higher ionic radius of Ca^{2} ion (0·99 Å). On further increasing the percentage of Ca^{2+} ions (composition C) a single pyrochlore phase with increased lattice constant (10·05 Å) was observed, which indicates that the brannerite phase has formed a solid solution with pyrochlore phase. In composition B with increased percentage of Ca^{2+} ions perovskite phase along with pyrochlore was obtained.

In the above pyrochlore structure Ca^{2+} (0·99 Å), Y^{3+} (0·92 Å) and U^{4+} (0·97 Å) are in the A sites while Ti^{4+} (0·68 Å) ions are in the B sites.

Department of Inorganic Chemistry, V. S. DARSHANE.
Institute of Science,
Nagpur,
and
Department of Chemistry, V. V. DESHPANDE.
Rajaram College,
Kolhapur, *February*, 12, 1971.

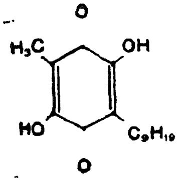
---

1. Machatschki, F., *Chem. Erde.*, 1932, **7**, 56.
2. Takubo, J., Ueda, T. and Nishimura, S., *J. Geol. Soc. Jap.*, 1951, **57**, 171.
3. Gasperin, M., *Bull. Soc. Franc. Miner. Crist.*, 1957, **80**, 232.
4. Hogarth, D. D., *Can. Min.*, 1959, **6**, 610.
5. Deshpande, V. V. and Rama Rao, K., *Curr. Sci.*, 1968, **37**, 668.

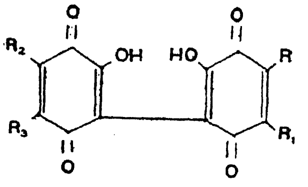
CHEMICAL EXAMINATION OF THE LEAVES OF *MAESA MACROPHYLLA* WALL A. DC

AN earlier publication[1] reports the isolation of bhogatin, its constitution and synthesis. We now report further studies on the chemical components of the leaves of *M. macrophylla*.

Extraction of the dry leaves with normal hexane gave (1) an alkali-soluble fraction from which bhogatin (I) has been isolated (Yield : 2·5%), besides a new quinone (II), m.p. 55–57° (Yield : 0·1%), u.v. $\lambda_{max.}$ ($CHCl_3$) 275 mμ (log ϵ, 4·51), 400–405 mμ (log ϵ, 2·98); i.r. ($CHCl_3$), 3420 cm^{-1} (OH) 1665–50, 1630 (> C : O) $cm.^{-1}$ Mass spectrum M^+ 526, molecular formula, $C_{32}H_{46}O_6$. It gives violet solutions with alkalies and a purple colouration with ferric chloride. It shows the properties of a p-quinone since it underwent ready reduction and reoxidation. It formed a diacetate, molecular formula, $C_{36}H_{50}O_8$, as a liquid and an acetate of its reduction product also as a colourless liquid. N.M.R. spectral studies of (II) indicated the following data : ($CDCl_3$) 2·8 τ (broad, 2 H, hydroxyls), 7·5–7·97 τ (benzylic methylenes, 4 H), 8·12 τ (ring methyls, 6 H singlet), 8·5–8·97 τ (centered at 8·82 τ, side-chain methylenes, 28–34 H), 9·2 τ (side-chain end methyls, 6 H, triplet, J = 5–6 cps). These results indicated that it is a dibenzoquinone having possibly the structure (II), which is named by us, macrophyllin. The occurrence of macrophyllin in plant products, a dibenzoquinone, is the first isolated so far, while phoenicin[2] and oosperin[3] are mould products. Oxidation of macrophyllin (1 mol.) with neutral permanganate gave two molecules of decoic acid, indicating thereby, that the side-chain in both the rings is $-C_9H_{19}$. Further, macrophyllin undergoes dehydration with concentrated sulphuric acid in dioxan to give anhydro-macrophyllin, the infrared spectrum showing clearly the absence of –OH frequencies. These reactions support the structure assigned to macrophyllin.



(I)



(II)

(*a*) $R=R_2=CH_3$; $R_1=R_3=C_9H_{19}$

(*b*) $R=R_2=C_9H_{19}$; $R_1=R_3=CH_3$

(*c*) $R=R_3=CH_3$; $R_1=R_2=C_9H_{19}$

The neutral fraction of the n-hexane extract gave β-amyrene, identified by comparison with an authentic sample of β-amyrene.

Subsequent extraction of the dry leaves with benzene to remove completely chlorophyll, followed by extraction with ethyl alcohol, gave a product which was separated into two fractions: (1) an ether-soluble fraction (A) and (2) an aqueous portion (B). The ether-soluble fraction (A) gave quercetin (yield, 0·05%), identified by paper chromatography in butanol-acetic acid-water (4 : 1 : 5) and 60% acetic acid, further confirmed by the preparation of its pentaacetate and pentamethyl ether.

The aqueous fraction (B) was worked up using basic lead acetate when a yellow lead salt was precipitated. Decomposition of the lead salt gave an impure yellow residue, m.p. 222–226°, which could not be purified and hence was subjected to acid hydrolysis giving rise to a yellow flavonoid, m.p. 312–314° which on chromatographic study in 60% acetic acid and butanol-acetic acid-water (4 : 1 : 5) showed that the product, 312–314°, is only quercetin contaminated with kaempferol. The sugar moiety was examined by paper chromatography, identified as galactose.

The authors desire to thank Dr. M. V. Tamhane and Mr. C. R. Rao, Botainst, of the Ministry of Agriculture, New Delhi, for the collection of the plant material, Dr. G. S. Sidhu of the Regional Research Laboratories, Hyderabad, for N.M.R. spectral data and the Director, National Chemical Laboratory, for mass spectral data.

Chemical Laboratories, K. R. Prabhu.
Andhra University, V. Venkateswarlu.
Waltair, *February* 15, 1971.

---

1. Chandrasekhar, C., Prabhu, K. R. and Venkateswarlu, V., *Curr. Sci.*, 1969, **38**, 15; *Phytochem.*, 1970, **9**, **415**.
2. Posternack, T., *Helv. Chim. Acta*, 1938, **21**, 1326.
3. Kogl, K. and van Wessein, G. C., *Rec. Trav. Chim.*, **1944**, **63**, 5.

THE VISIBLE ELECTRONIC ABSORPTION SPECTRUM OF *BIS* (2-METHYLPYRIDINE) NICKEL (II) CHLORIDE IN 2-METHYLPYRIDINE

Quagliano *et al.*[1] first reported the preparation of *bis* (2-methylpyridine) nickel(II) chloride. On the basis of its magnetic moment, diffuse reflectance spectrum and dark blue colour, they reported the complex had a pseudotetrahedral structure in the solid state. Quagliano and different co-workers[2] later prepared the complex using the original method and claimed the absorption spectrum indicated the complex was also tetrahedral in dichloromethane, but, they did not give any spectral details.

The thermal decomposition of the complex was later studied by Allan *et al.*[3] and Beech *et al.*[4] However, Allan *et al.* claimed that the complex prepared by them, using the method of Quagliano and co-workers,[1,2] was yellow in colour and possessed an absorption spectrum characteristic of octahedral nickel (II). The difference between the yellow complex prepared by Allan *et al.*[3] and the blue complex of Quagliano *et al.*[1] was explained as due to different forms of the same complex.

We now report a new method for the preparation of *bis*(2-methylpyridine)nickel(II) chloride which yields a product of high purity, and report for the first time its visible absorption spectrum in 2-methylpyridine.

The colour of the complex is deep purplish-blue in the solid state. Solutions of it in 2-methylpyridine are the same deep colour. The agreement between the solid state spectrum and the solution spectrum in 2-methylpyridine can be seen from Fig. 1 where both spectra are shown. The absorption spectrum in 2-methylpyridine has four bands, one of low intensity at 428 mμ and three overlapping bands of high intensity at 528, 575 and 608 mμ, with maximum absorption at 608 mμ ($\epsilon = 180$). The extinction coefficients and position of the absorption bands in 2-methylpyridine are consistent with those reported for tetrahedral heterocyclic base complexes of nickel(II) in solvents such as dichloromethane and chloroform.[2,5,6]

The necessity for anhydrous solvent free from other methylpyridine isomers, in order to preserve the tetrahedral structure of nickel(II) in 2-methylpyridine, may be readily demonstrated. The addition of trace amounts of either water or 3- or 4-methylpyridine to the deep purplish-blue solution of nickel(II) in 2-methylpyridine, results in a colour change to deep-green. The absorption spectrum of this green solution possesses absorption bands of low intensity characteristic of octahedral nickel(II). The susceptibility of the 2-methylpyridine solution of nickel(II) to these above-mentioned effects, which result in change of solution stereochemistry for the nickel (II) species, is in sharp contrast to the corresponding solution of cobalt(II) in 2-methylpyridine, where the tetrahedral species of cobalt(II) is maintained even with moderate concentration of water or other methylpyridine isomers.[7]

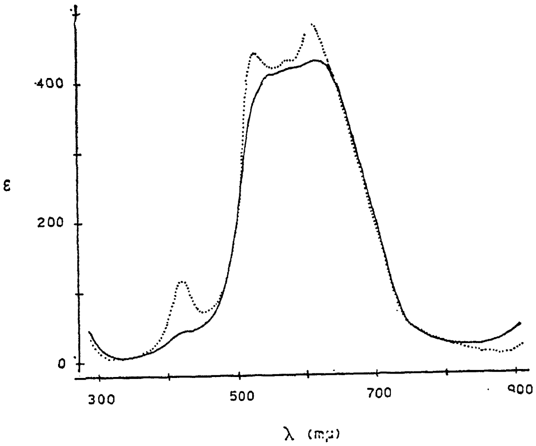


FIG. 1. Diffuse reflectance spectrum of *bis* (2-methylpyridine) nickel(II) chloride (——); Solution spectrum of $2 \cdot 72 \times 10^{-3}$ M *bis* (2-methylpyridine) nickel (II) chloride in 2-methylpyridine (....).

EXPERIMENTAL

Bis(2-methylpyridine) nickel(II) chloride was prepared by boiling 10 g hydrated nickel (II) chloride (Merck G.R.) with 100 ml 2-methylpyridine (Schuchardt) for 30 minutes, the solution filtered hot and allowed to cool in a stoppered flask. The cold solution was allowed to stand 24 hours after which time crystals separated out. The deep purplish-blue crystals, obtained from the 2-methylpyridine, were recrystallised twice by the same method, dried over P_2O_5 and analysed for C, H, N. Calculated for $Ni(C_6H_7N)_2Cl_2$: C, 45·6 ; H, 4·5 ; N, 8·9. Found : C, 45·2 ; H, 4·3 ; N, 8·5.

Schuchardt 2-methylpyridine was redistilled twice over potassium hydroxide and then stored over potassium hydroxide pellets. The purity of the solvent was checked by gas chromatography using a 5 ft. column of 10% triethanolamine on Chromosorb W (80/100 mesh) with an oven temperature of 70° C. Chromatograms were determined on a Varian Aerograph Model 1520.

Spectra were determined on a Zeiss PMQ II Spectrophotometer.

We wish to thank Dr. E. Challen for the micro-analysis.

G. H. AYLWARD.[*]
R. W. LEE.[‡]
E. C. WATTON.[*]

May 7, 1971.

---

[*] School of Chemistry, Macquarie University, North Ryde, New South Wales, 2113.

[‡] School of Chemistry. University of New South Wales, Kensington New South Wales, 2033.

[‡] Present Address: National Biological Standards Laboratory, P.O. Box 462, Canberra City, A.C.T., 2601, Australia.

1. Glonek, Sr. M. D., Curran, C. and Quagliano, J. V., *J. Amer. Chem. Soc.*, 1962, **84**, 2014.
2. Vallarino, L. M , Hill, W. E. and Quagliano, J. V., *Inorg. Chem.*, 1965 **4**, 1598.
3. Allan, J. R., Brown, D. H., Nuttall, R. H. and Sharp, D. W. A., *J. Inorg. Nucl. Chem* , 1965, **27**, 1529.
4. Beech, G., Mortimer, C. T. and Tyler, E. G., *J. Chem. Soc.*, 1967, p. 1111.
5. Buffagni, S., Vallarino, L. M. and Quagliano, J. V., *Inorg. Chem.*, 1964, **3**, 480.
6. Nelson, S. M and Shepherd, T. M., *J. Chem. Soc* , 1965, p. 3276.
7. Graddon, D. P. and Watton, E. C., *Aust. J. Chem.*, 1965, **18**, 507.

SOME NEW BENZOTHIAZOLYL GUANIDINES

SEVERAL biological activities associated with substituted guanidines, *viz.*, algaecidal,[1] antibacterial,[2] antitubercular,[3] hypoglycemic,[4] etc., have stimulated the author to conduct research in this line. These benzothiazolyl guanidines have been synthesised by desulphurisation of corresponding benzothiazolyl thiocarbamides with yellow lead oxide in ethanolic alkyl amines.

EXPERIMENTAL

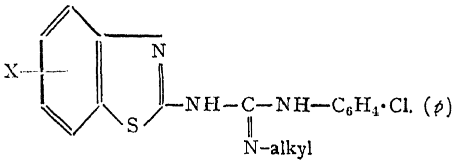
N-p-Chlorophenyl-N′-2-(substituted) benzothiazolyl thiocarbamides.—These were prepared by taking a requisite amount of 2-amino (substituted) benzothiazoles and *p*-chlorophenyl-isothiocyanate in dry benzene as reported earlier.[5]

N - p -Chlorophenyl - N′-2-benzothiazolyl-N″-n-propyl guanidine.—A mixture of N-*p*-chlorophenyl-N′-2-benzothiazolyl thiocarbamide (0·01 mole), *n*-propylamine (0·011 mole) and yellow lead oxide (0·021 mole) in ethanol (30 ml) was refluxed in a sealed tube on a water-bath for 4 hr. After removing the lead sulphide by filtration, the filtrate was concentrated to get the corresponding guanidine. It was recrystallised from ethanol.

Likewise, various N-*p*-chlorophenyl-N′-2-(substituted)-benzothiazolyl-N″-alkyl guanidines were synthesised from N-*p*-chlorophenyl-N′-2-

TABLE I

N-p-Chlorophenyl-N'2-(substituted) benzothiazolyl-N"-alkyl guanidines



S. No.	Substituent X	Yield %	M.P. °C	Molecular formula	Nitrogen, % Found	Nitrogen, % Calcd.	Sulphur, % Found	Sulphur, % Calcd.
				Alkyl = *n*-propyl				
1	H	80	97	$C_{17}H_{17}ClN_4S$	16·01	16·26	9·34	9·29
2	4-Methyl	74	121	$C_{18}H_{19}ClN_4S$	15·73	15·63	8·85	8·92
3	5-Methyl	78	137	$C_{18}H_{19}ClN_4S$	15·61	15·63	9·00	8·92
4	6-Methyl	75	104	$C_{18}H_{19}ClN_4S$	15·45	15·63	8·90	8·92
5	4-Chloro	73	115	$C_{17}H_{16}Cl_2N_4S$	14·83	14·78	8·40	8·44
6	5-Chloro	60	119	$C_{17}H_{16}Cl_2N_4S$	14·89	14·78	8·58	8·44
7	6-Chloro	65	129	$C_{17}H_{16}Cl_2N_4S$	14·67	14·78	8·60	8·44
8	4-Methoxy	60	126	$C_{18}H_{19}ClN_4OS$	15·00	14·95	8·68	8·54
9	6-Methoxy	57	97	$C_{18}H_{19}ClN_4OS$	14·90	14·95	8·60	8·54
10	6-Ethoxy	68	136	$C_{19}H_{21}ClN_4OS$	14·31	14·42	8·18	8·23
				Alkyl = isopropyl				
11	H	69	107	$C_{17}H_{17}ClN_4S$	16·39	16·26	9·42	9·29
12	4-Methyl	77	126	$C_{18}H_{19}ClN_4S$	15·48	15·63	9·12	8·92
13	5-Methyl	68	129	$C_{18}H_{19}ClN_4S$	15·79	15·63	9·15	8·92
14	6-Methyl	70	204	$C_{18}H_{19}ClN_4S$	15·37	15·63	8·82	8·92
15	4-Chloro	80	151	$C_{17}H_{16}Cl_2N_4S$	15·00	14·78	8·55	8·44
16	5-Chloro	75	125	$C_{17}H_{16}Cl_2N_4S$	14·65	14·78	8·37	8·44
17	4-Methoxy	74	133	$C_{18}H_{19}ClN_4OS$	14·75	14·95	8·45	8·54
18	6-Methoxy	65	141	$C_{18}H_{19}ClN_4OS$	14·83	14·95	8·39	8·54
19	6-Ethoxy	83	124	$C_{19}H_{21}ClN_4OS$	14·58	14·42	8·40	8·23

(substituted) benzothiazolyl thiocarbamides and different alkyl amines in presence of yellow lead oxide and ethanol (Table I).

3-p-Chlorophenyl-2-(4'-methyl) benzothiazol-2'-ylimino-4-phenyl thiazole.—N-p-Chlorophenyl-N'-2-(4-methyl) benzothiazolyl thiocarbamide (3·3 g), acetophenone (1·2 ml) and iodine (2·54 g) were refluxed on a water-bath for 16 hr. Excess of iodine was removed by washing with ether and the crude product was washed with hot water and filtered. It was crystallised from ethanol. Yield 88%, m.p. 188° C (Found: N, 9·38. $C_{23}H_{16}ClN_3S_2$ requires N, 9·69%).

Thanks to Dr. P. N. Bhargava for his supervision and to the Council of Scientific and Industrial Research for the award of Junior Research Fellowship are gratefully acknowledged.

Dept. of Chemistry, V. N. CHOUBEY.
Faculty of Science,
Banaras Hindu University,
Varanasi-5, *February* 8, 1971.

---

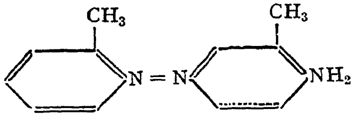
1. Singh, G. C., *J. Ind. Chem. Soc.*, 1968, **45**, 27.
2. Bhargava, P. N. and Choubey, V. N., *Agr. Biol. Chem.*, **1970**. **34**, **644**.
3. — and Chaurasia, M. R., *Curr. Sci.*, 1968, **37**, **347**.
4. Ludwig, B. J., Reisner, D. B., Meyer, M., Powell, L. S., Simet, L. and Stiefel, F. J., *J. Med. Chem*, 1970, **13**, 60.
5. Bhargava, P. N. and Ram, P., *Ind. J. Appl. Chem.*, **1961**, **24**, **181**.

A NEW COLOUR REAGENT FOR THE DETECTION OF ACID PHOSPHATASE IN HUMAN SEMEN

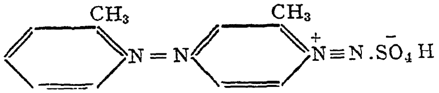
WITH the discovery of high acid phosphatase activity in human semen by Kutscher and Wolbergs,[1] tests have been developed to identify the enzyme in suspected seminal stains encountered commonly in Forensic Science.

Acid phosphatases possess the property of hydrolysing organic phosphates in mildly acid media. One of the artificial substrates used is phenyl phosphate which is hydrolyzed by the enzyme to give free phenol and inorganic phosphate. Phenol is estimated by the method of Folin and Ciocalteu. Phenolic substances possess the property of coupling with diazonium salts to give insoluble and highly coloured azo-dyes, a property which is commonly employed in the detection of acid phosphatase.

Some of diazonium salts like Brentamine Fast Blue salt B, Fast Navy Blue salt R.A., Fast Black Salt K, Fast Blue salt B and Fast Red Salt A.L. have been used by earlier workers. In the present communication a method is described for the detection of acid phosphatase in semen employing an hitherto untried diazonium salt namely Fast Garnet GBC salt of the following structural formula, which has given very satisfactory results.



The amine $C_{14}H_{15}N_3$
Mol. wt. 225·298
(O-Aminoazotoluene)



The acid sulphate
Mol. wt. 334·364

For making the reagent 2 gm of sodium acetate trihydrate, 0·5 ml glacial acetic acid and 0·5 ml of solution of calcium α-naphthyl phosphate (1 gm per 5 ml in acetone) are dissolved in 100 ml of distilled water. To this 100 mg of GBC salt is added and the reagent thus prepared is used for detection of acid phosphatase. The results obtained are tabulated in Table I.

TABLE I

Semen stain	Colour obtained with the new reagent	Time taken for appearance of the colour at room temperature
1. Fresh stain (undiluted) on filter-paper	Pink	5 seconds
2. Fresh stain (1 : 10 dilution) on filter-paper	,,	,,
3. Fresh stain (1 : 100 dilution)	,,	,,
4. 6–7 months old semen stain on clothing	,,	,,
5. Filter-paper soakings of the old stains (S. No. 4)	,,	,,
6. Normal saline control	No colour	,,

Forty-four stable diazonium salts were tested by Home Office, Central Research Establishment, Aldermaston, Berks (England) and out of these Fast Navy Blue salt R.A. and Fast Black salt K were recommended satisfactory for general application. Fast Garnet GBC salt has been tried for the first time and the colour reaction with this is found to be very prominent with seminal stains on the clothings as well as on filter-paper soakings.

Biology Division, R. Y. P. BHATIA.
Central Forensic Sci., Lab.,
(M.H.A.) Government of India,
Chirag Ali Lane,
Hyderabad-1 (A.P.), *February* 15, 1971.

---

1. Kutscher, W. and Wolbergs, H., *Z. Physiol. Chem.*, 1935, **236**, 237.

IS TEAK (*TECTONA GRANDIS*) A CALCICOLE?

EARLIER, in their studies on the teak (*Tectona grandis* Linn. f.) forests of Madhya Pradesh, Bhatia (1954), Kulkarni (1951) and Puri (1951) have observed that teak is a 'Calcicole' species and they have drawn a positive relation of soil calcium and igneous volcanic eruptions on the growth and distribution of teak, in different localities of the State.

While working on the Ecology of River Narmada Upper Catchment Area, an attempt has been made to see if there is really a positive correlation between growth and distribution of teak in different associations and calcium content in the respective underlying soils. The forest vegetation in the Upper Catchment Area of River Narmada from Manot to Jabalpur has been classified into eleven forest associations as described earlier by Pandeya, Pandya, Murthy and Kuruvilla (1967). The position of teak in these eleven associations was judged upon by calculating the Relative Growth Index (RGI) and Coefficient of Variation (CV). The highest value of RGI and lowest value of CV in the associations for teak indicate domination of teak as shown in Table I.

It is evident from Table I, that the first four associations are dominated by teak, the rest carry teak as a component species only, whereas, in associations numbered 6 and 11, teak is totally absent.

The underlying soil samples were collected by profile method and analysed for their physico-chemical nature. Soil exchangeable calcium was estimated as per the method outlined

TABLE I

No.	Association	Teak	
		RGI	CV
1	Teak-*Terminalia alata*	7·20	0·80
2	Teak-*Anogeissus latifolia*	5·70	0·70
3	Teak-*Dendrocalamus strictus*	4·10	0·95
4	Teak-*Butea monosperma*	5·60	1·10
5	*Terminalia arjuna-Anogeissus latifolia*	0·08	1·30
6	*Dendrocalamus strictus-Terminalia alata*	Absent	
7	*Terminalia alata-Anogeissus latifolia*	0·60	1·84
8	*Madhuca indica-Anogeissus latifolia*	0·004	2·00
9	*Anogeissus latifolia-Ougeinia oojeinensis*	0·011	2·10
10	*Anogeissus latifolia-Diospyros melanoxylon*	0·012	2·00
11	*Acacia catechu-Lannea coromandalica*	Absent	

by Piper (1944). Mean values of soil exchangeable calcium and the standard deviation thereof in the soil samples of the different associations listed above are shown in Fig. 1. Figure 1 clearly shows that there is no strict correlation between the growth and distribution of teak in the different associations and soil calcium in the respective soils. This observation has been confirmed by working out Correlation Coefficient (r) between the different RGI values of teak under different associations and calcium content in the corresponding soil samples. The value of 'r' worked out to 0·058, showing that there is no positive correlation between the two variables. Thus, this study confirms that soil calcium has no decisive role on the growth and distribution of teak, at least in the study area mentioned. However, the problem evoked in this direction needs more intensive studies.

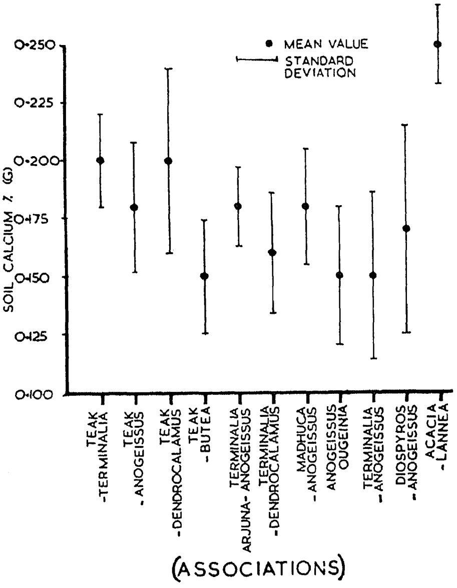


FIG. 1

Dept. of Biosciences, M. SREEDHAR MURTHY.
Saurashtra University,
Post Bag No. 9,
Rajkot (Gujarat), *November* 16, 1970.

---

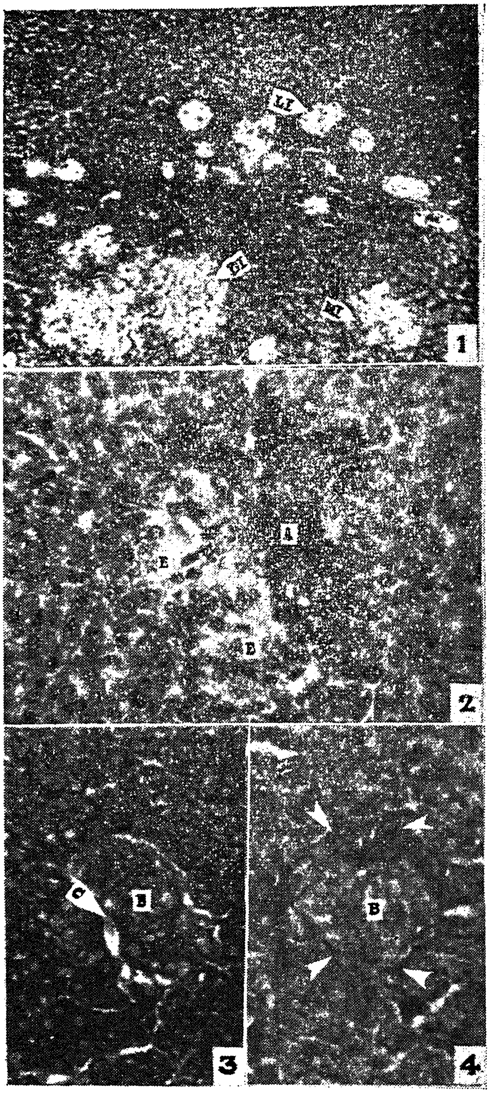
1. Bhatia, K. K., "Calcium as a factor in the ecology of teak," *Proc. Nat. Acad. Sci. India*, **1954.**
2. —, "Factors in the distribution of teak in Madhya Pradesh," *J. Indian Bot. Soc.*, 1955 **34 (4), 459.**
3. Kulkarni, "Distribution of teak on the northern slopes of Satpuras with special reference to geology," *Proc. 8th Silv. Conf.*, Dehra Dun, 1951.
4. Pandeya, S. C., Pandya, S. M., Murthy, M. S. and Kuruvilla, K., "Forest ecosystem: Classiffication of forest vegetation with special reference to forests in the river Narmada Catchment Area," *J. Indian bot. Soc.*, 1967, **46**, 4.
5. Piper, C. S., *Soil and Plant Analysis*, Adelaide University Press, Australia, 1944.
6. Puri, G. S., "Advances in the ecology of teak (*Tectona grandis*) in India," *Proc. 8th Silv. Conf.*, Dehra Dun, 1951.

ISLET CYTOLOGY OF *TRINGA GLAREOLA* LINNAEUS (FAMILY CHARADRIIDAE)

EXTENSIVE work has been done on islet cytology of mammals especially those which form the experimental diabetic animals. Recently, more attention is being paid to such a study in the lower vertebrates (Epple, 1968; Sivadas, 1968). The reports on the islets of birds are limited only to a very few species (Hellman and Hellerstrom, 1960; Epple, 1961; Mikami and Ono, 1962; George and Naik, 1964; Epple and Farner, 1967). The present report deals with the islet cytology of a migratory bird, *Tringa glareola*, as a preliminary attempt to study the seasonal changes in the endocrine pancreas.

T. glareola breeds in Central Asia and migrates to South India during winter (Salim Ali, 1969). Specimens of the bird were captured on the banks of Adyar estuary, Madras, during the months of October-November, 1970. Live birds were transferred to the laboratory and killed. Pieces of pancreas were fixed in Bouin's fluid for 12 hours. Further processing was carried out according to the suggestions of Epple (1967). Sections of 5 μ thickness were cut and stained by the following techniques: (1) Iron alum haematoxylin and eosin to study the distribution of islets; (2) Phosphotungstic acid haematoxylin

(Levene and Feng, 1964) to observe the A-cells; (3) Aldehydefuchsin (Gabe, 1953) and counterstain to locate the B-cells; (4) Silver impregnation of Hellerstrom and Hellman, (1960) to locate the D-cells.



FIGS. 1–4. Photomicrographs of sections through pancreas of *T. glareola*. Fig. 1. Three types of islets. DI, Dark islet; LI, Light islet; MI, Mixed islet. Iron alum haematoxylin-eosin, × 100. Fig. 2. Mixed islet. A, A-cells; B, B-cells. Phosphotungstic acid haematoxylin, × 400. Fig. 3. Light islet. B, B-Cells; C, Capillary. Aldehydefunchsin-counterstain, × 400. Fig. 4. Light islet. Arrow heads, D-cells; B, B-cells. Silver impregnation, × 400.

In *T. glareola* the islets of Langernans are distributed throughout the pancreas, but they are concentrated more in the splenic part of it than in other regions. As in other birds three types of islets are seen, the 'dark islets' containing A- and D-cells, the 'light islets' with B- and, sometimes, D-cells, and the 'mixed islets' having all the three types of cells (Fig. 1). The 'dark islets' are generally large compared to the other two types. The 'light islets' are the smallest of the three types and they comprise, usually, a row of elongated B-cells surrounding a capillary and the peripherally located D-cells. The 'dark islets' consist of A-cells and D-cells, the latter being arranged along the capillary wall. The 'mixed islets' are medium in size and they appear to have been formed by the apposition of 'light islets' and 'dark islets'. The 'light islets' are more in number than the 'dark islets' while the 'mixed islets' are relatively few.

The A-cells are negative to aldehydefuchsin and silver impregnation. The A-granules are stained blue by the phosphotungstic acid haematoxylin (Fig. 2). The B-cells, which are elongated and columnar, are positive to aldehydefuchsin and negative to silver impregnation; and they remain mauve when stained with phosphotungstic acid haematoxylin (Figs. 2–4). The aldehydefuchsin positive granules are often seen concentrated at one pole of the cells, towards the capillary wall. The D-cells are characterised by their silver positive granules (Fig. 4). These granules are also stained blue by the phosphotungstic acid haematoxylin technique. All the islet cells appear to be in active stage, having full granulation and big nuclei with conspicuous nucleoli. No difference in the activity of the different islets or islets of the different individuals is observed.

The above results show that the distribution of the islets of *Tringa glareola* is quite similar to that of other birds (Hellman and Hellerstrom, 1960; Epple, 1961; Mikami and Ono, 1962; Epple and Farner, 1967). The occurrence of the three types of cells is also in corroboration with the earlier findings (Epple, 1968).

Our thanks are due to the Principal and Board of Trustees of Pachaiyappa's College, Madras, for facilities and encouragement.

Dept. of Zoology, N. P. KALYANAM.
Pachaiyappa's College, N. GURUMANI.
Madras-30, India, *February* 8, 1971.

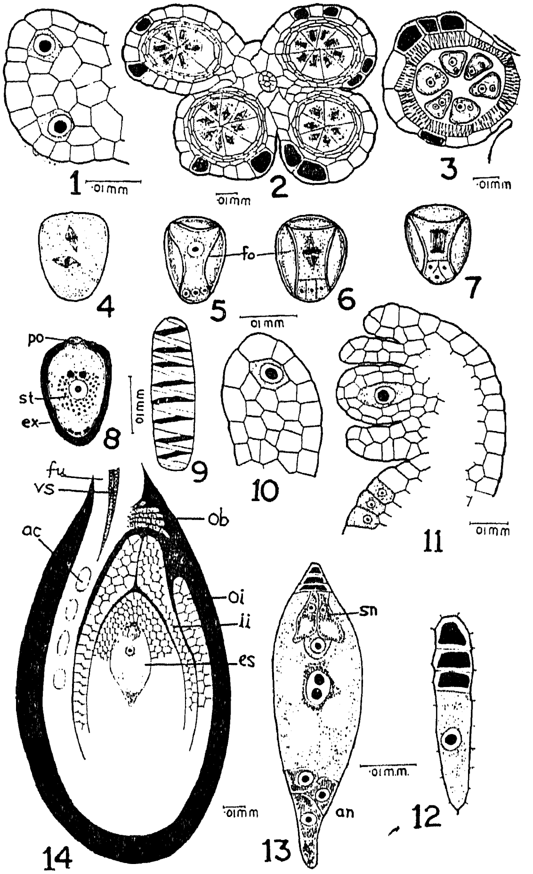
1. Epple, A., *Z. Zellforsch.*, 1961, **53, 731.**
2. —, *Stain Techn.*, 1967, **42,** 53.
3. —, *Endocrinol. Japon.*, 1968, **15,** 107.
4. — and Farner, D. S., *Z. Zellforsch.*, 1967, **79, 185.**
5. Gabe, M., *Bull. Micr. Appl. Paris*, 1953, **2, 154.**
6. George, J. C. and Naik, D. V., *Pavo.*, 1964, **2, 88.**
7. Hellerstorm, C. and Hellman, B., *Acta Endocrinol.*, 1960, **35,** 518.
8. Hellman, B. and Hellerstrom, C., *Z. Zellforsch.*, 1960, **52,** 278.
9. Levene, C. and Feng, P., *Stain Techn.*, 1964, **39, 39.**
10. Mikami, S. I. and Ono, K., *Endocrinology*, 1962, **71, 464.**
11. Salim Ali and Ripley, S. D., *Hand Book of the Birds of India*, Oxford University Press, 1969, **2.**
12. Sivadas, P., *Ph.D. Thesis*, Annamalai University, 1968.

GAMETOPHYTES OF *CYPERUS ALTERNIFOLIUS* LINN.

Cyperus alternifolius Linn., the common umbrella plant, is the only ornamental sedge commonly grown in the garden and is found in the warmer regions of the world (Lawrence, 1963). The present note relates to the male and female gametophytes of this taxon.

The anthers are tetrasporangiate. The male archesporium is hypodermal and unicellular (Fig. 1). However, multicellular archesporium for the family is reported by Padhye (1960, 1967, 1968) and Shah (1962). A four-layered anther wall developing according to monocotyledonous type of Davis (1966) is formed (Fig. 2). At anthesis anther wall shows epidermis with some tannin-filled cells and hypodermal endothecium with constituent cells possessing distinct lignified spiral thickenings (Figs. 3, 9). The middle layer is ephemeral. The secretory tapetum is uninucleate. Meiotic divisions (Figs. 2, 4) are not synchronous in sporogenous cells in four lobes of anther. The 'pseudomonad' at close of meiosis shows 1 + 3 arrangement of nuclei and folds appear on the wall of the young microspore (Fig. 5). Septum formation is observed between functional and non-functional nuclei as also between the latter (Figs. 6, 7). Mature pollen grains are monoaperturate, 3-celled and show starch grains. The remains of effete nuclei persist in them (Fig. 8) unlike in other members of the family where they are absorbed by this stage.

The single ovule arising from the base of ovary is anatropous, bitegmic and crassinucellate. The micropyle is organised by the inner integument. The outer integument on the funicular side is absent (Fig. 14). The funicular region shows presence of air chambers a short distance from the vascular strand (Fig. 14). This character not recorded so far in any member of the family seems to be an adaptation to aquatic habitat. It is further interesting to note that the vascular strand fades away immediately after entering the funiculus unlike in others where it goes right upto the chalazal end of ovule terminating below the hypostase.



FIGS. 1–14. Figs. 1–3. T.S. anther showing wall formation. Figs. 4–7. Stages in development of pollen-grain. Fig. 8. Mature pollen-grain. Fig. 9. Single endothecial cell showing spiral thickening. Fig. 10. Female archesporium. Fig. 11. Megaspore mother cell. Fig. 12. Megaspore tetrad. Fig. 13. Embryo-sac. Fig. 14. L.S. ovule showing embryo-sac, obturator and air chambers. (*ac*, air chambers; *an*, antipodals; *es*, embryo-sac; *ex*, exine; *fo*, folds; *ii*, inner integument; *ob*, obturator; *oi*, outer integument; *po*, pore; *st*, starch; *sn*, synergids; *vs*, vascular strand; *fu*, funiculus.)

The female archesporium is a single hypodermal cell (Fig. 10). It divides periclinally. A parietal tissue of 3 layers is developed (Fig. 14) as in *Eleocharis geniculata* (Padhye, 1968). In *Fimbristylis quinquangularis*

(Dnyansagar and Tiwari, 1956) and *Scirpus mucronatus* (Padhye, 1967) it is massive and consists of six to eight layers. Meiotic divisions in megaspore mother cell (Fig. 11) result in a linear tetrad of megaspore (Fig. 12). The functional chalazal megaspore develops into the Polygonum type of megagametophyte (Fig. 13). At the base of funiculus, a group of superficial cells divide and redivide to form a bundle of elongated, flexuous cells that loosely cover the micropylar region. This constitutes funicular obturator (Fig. 14). It is reported earlier in the family by Padhye (1960, 1968).

We are grateful to Dr. M. D. Padhye for guidance, and to Prof. L. B. Kajale, for kindly going through the manuscript.

Dept. of Botany,
Nagpur University,
Nagpur, *February* 3, 1971.

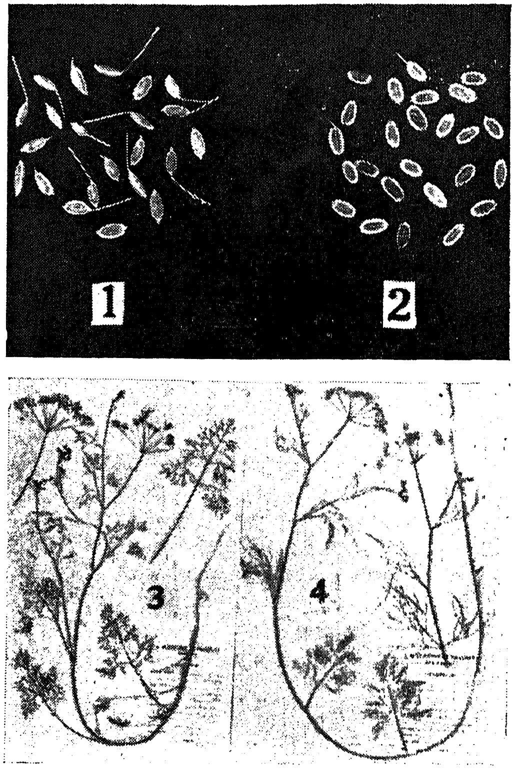
A. G. Untawale.
K. H. Makde.

---

1. Davis, G. L., *Systematic Embryology of Angiosperms*, 1966, p. 10.
2. Dnyansagar, V. R. and Tiwari, D. K., *Bull. bot. soc. Univ. Saugar*, 1956, **8**, 3.
3. Lawrence, G. H. M., *Taxonomy of Vascular Plants*, 1963, p. 392.
4. Padhye, M. D., *Bull. Bot. Soc. Coll. Sci. Nagpur*, 1960, **1**, 1.
5. —, *Ph.D. Thesis*, Nagpur University, 1967.
6. —, *Proc. Indian Acad. Sci.*, 1968, **67**, 54.
7. Shah, C. K., *Plant Embryology—A Symposium*, C.S.I.R., 1962, p. 81.

INTRASPECIFIC VARIABILITY IN INDIAN DILL

In the local market of Gujarat we came across two varieties of Indian dill, the fruits of *Anethum sowa*. These varieties not only differ in their morphological characters but also show distinct differences in their oil composition. One of these varieties, consisting of cremocarps, is considered to be superior and is known as Variyali sowa (Fennel sowa) (Fig. 1). The other cheaper variety occurs as separate mericarps and is known as Ghoda sowa (Horse sowa) (Fig. 2). Ghoda sowa is used as animal food and in veterinary practice while the superior variety of Fennel sowa is used as a spice and as an ingredient of aromatic carminative preparations. The volatile oil[1] of cremocarp variety contains 21% carvone and 43% dihydrocarvone, while the mericarp variety contains 34% carvone and 15% dihydrocarvone. The percentage of dillapiole in both the varieties is 12-15%. On the basis of these findings of oil composition, these two varieties of Indian dill are considered as dillapiole mitis race with two subraces, one carvone subrace and the other dihydrocarvone subrace. Since these two varieties of sowa dill differ both in morphological characters and in oil composition, it was considered of interest to study the intraspecific variations in the plants of the two varieties.



Figs. 1–4. Fig. 1. Fruits of cremocarp variety (Variyali sowa). Fig. 2. Fruits of mericarp variety (Ghoda sowa). Fig. 3. Pressed plant specimen of Variyali sowa. Fig. 4. Pressed plant specimen of Ghoda sowa.

The plants of both the varieties were cultivated in the pharmacognosy garden and the variations at different stages of development were observed. Variyali sowa plant looked tender and grew less vigorously than the plant of Ghoda sowa. The different characters shown by the plants of both the varieties (Figs. 3 and 4) are given in Table I.

The differences in Table I in the two varieties of Indian dill suggest that besides the chemical subraces, there exists intraspecific variability too in Indian dill.

TABLE I

Description		Variyali sowa	Ghoda sowa
Height of the plant	..	50–80 cm	75–100 cm
Roots	..	Thin and wiry	Stout, long and tapering
Transitional region	..	Thin, elongated and with distinct purple colour	Very short, stout and without any characteristic colour
Leaves	..	Decompound with sheathing leaf bases Pinules upto 1 cm in length, linear and somewhat flattened	Decompound with prominent sheathing leaf bases Pinules 1–5 cm in length, filiform and elongated
Young leaf and flower-buds	..	Both with purplish tinge	Only flower-buds with purplish tinge
Length of the primary peduncle	..	5–11 cm	3–6 cm
Type of fruit	..	Cremocarp	Mericarp
Shape of fruit	..	Ovate oblong	Oblong
Size of fruit	..	4·5–5·7 mm in length 1·6–2·3 mm in breadth	4·5–5·5 mm in length 2·1–2·5 mm in breadth
Wings of fruit	..	Less prominent 0·1–0·2 mm in breadth	Prominent 0·3–0·4 mm in breadth
Weight of 100 fruits	..	540–620 mg	240–280 mg
No. of fruits in 1 gm	..	171	376

The authors acknowledge thanks to Dr. C. K. Atal, Assistant Director, Regional Research Laboratory, Jammu, for his interest in this work.

Department of Pharmacognosy,
L.M. College of Pharmacy,
Ahmedabad-9, *February* 8, 1971.

C. S. SHAH.
J. S. QADRY.
(MRS.) M. G. CHAUHAN.

---

1. Shah, C. S., Qadry, J. S. and Chauhan, M. G., *J. Pharm. Pharmacol.*, 1971 (In press).

NUCLEAR INSTABILITY AND CHROMOSOMAL VARIABILITY IN THE SOMATIC CELLS OF TWO GAMMA-IRRADIATED MUTANTS FROM JRO-632, A PROMISING STRAIN OF *CORCHORUS OLITORIUS* LINN. (JUTE)

JRO-632 is a promising *olitorius* jute strain raised at the Jute Agricultural Research Institute, Barrackpore, a few years back. At 10,000 r (Cesium 137), a mutant (named as crumpled leaf mutant) was obtained at M_1 generation by Neogy[1] of this Department, who regarded it as a gene mutant based on cytogenetic studies. In the M_2 generation two different new types of mutant suddenly developed—(1) crumpled leaf pure green and (2) crumpled leaf red. In the succeeding generations they bred true and were found to be stable. It was reported by Patel and Datta[2] that a new type of mutant may arise from a normal looking fasciated mutant of *olitorius* x-irradiated with 30,000 r. These two new mutants are capable of yielding more fibres according to Chatterjee.[3] In the present study somatic chromosome numbers were counted in root tip cells which show instability and variability following aceto-orcein squash schedule.

Normal diploid somatic complement of this strain is 14 in all cases. In the different root tip cells of the crumpled leaf red mutant, somatic chromosome numbers were noted plant-wise and their variations are shown in Table I.

TABLE I

Showing variability in somatic chromosome numbers in the crumpled leaf red mutant

Plant No.	Ranges of somatic chromosome number	Mean	± S.E.
1	11, 13, 15	13·00	1·15
2	10, 15, 17	14·00	2·08
3	14, 15, 16	15·00	0·57
4	11, 12, 13	12·00	0·57
5	13, 14, 15	14·00	0·57
6	13, 16, 18	15·66	1·46
7	10, 11, 12	11·00	0·57
8	10, 11, 12	11·00	0·57
9	11, 12, 13	12·00	0·57
10	8, 10, 12	10·00	1·15
11	10, 11, 12	11·00	0·57
12	8, 9, 10	9·00	0·57
13	11, 12, 13	12·00	0·57
14	8, 10, 12	10·00	1·15
15	11, 12, 13	12·00	0·57
16	13, 14, 15	14·00	0·57
17	13, 15, 16	14·66	0·89
18	12, 13, 14	13·00	0·57
19	13, 14. 18	15·00	1·53
20	11, 14, 17	14·00	1·73

It will be seen that means vary from 9·00 to 15·66. Chromosome numbers range from 8 to 18 showing plasticity in the ploidy level.

In the different root tip cells of the crumpled leaf green mutant also, somatic chromosome numbers were noted plant-wise and their variations are shown in Table II.

TABLE II

Showing variability in somatic chromosome numbers in the crumpled leaf green mutant

Plant No.	Range of somatic chromosome number	Mean	± S.E.
1	15, 17, 19	17·00	1·15
2	13, 14, 15	14·00	0·57
3	11, 13, 14	12·66	0·89
4	12, 13, 14	13·00	0·57
5	11, 14, 18	14·33	2·03
6	14, 15, 16	15·00	0·57
7	16, 17, 21	18·00	1·53
8	14, 17, 21	17·33	2·03
9	14, 14, 16	14·66	0·21
10	14, 15, 19	16·00	1·53
11	11, 12, 16	13·00	1·53
12	13, 17, 21	17·00	2·31
13	13, 15, 17	15·00	1·15
14	13, 16, 19	16·00	1·73
15	11, 14, 18	14·33	2·03
16	13, 13, 14	13·33	0·11
17	14, 17 21	17·33	2·03
18	9, 13, 15	12·33	1·76
19	13, 14, 15	14·00	0·57
20	11, 17, 20	16·00	2·64

Table II reveals that means vary from 12·33 to 18·00 with chromosome numbers ranging from 9 to 21. These again indicate plasticity in the ploidy level.

Chromosomal variability was reported in $2n$ *Elephantopus scaber* (Ayyangar and Sampath Kumar[4]) and various other plants (*cf.* Fukumoto[5]). This phenomenon is interpreted differently by different workers. They ascribed this to hereditary spindle abnormalities, certain combinations, cytomixis, actions of some metabolic products, etc.

In polyploids mixoploid somatic cell (*cf.* Raghuvanshi and Joshi[6]) are found in many instances but so far no report is found in irradiated materials. These jute mutants are, therefore, new types of gene mutants as referred to by Neogy[1] but they appear to be secondarily derived mutants in their chromosomal instability. The high amount of chromosomal variability in these two mutants can only be explained by assuming that the gene or genes responsible for regulated chromosome mechanism have undergone mutation so that chromosomal variabilities are manifested in different somatic cells of these two mutants.

Dept. of Agriculture, P. K. SASMAL.
Calcutta University, R. M. DATTA.
January 12, 1971.

---

1. Neogy, A. K., *Unpublished. D. Phil.* (*Agri.*) *Thesis*, submitted to the University of Calcutta in 1967.
2. Patel. G. I. and Datta, R. M., *Nucleus*, 1960, **3** (1), 125.
3. Chatterjee, (Miss) K., *Unpublished M Sc.* (*Ag.*) *Thesis*, Calcutta University.
4. Ayyangar, K. R. and Kumar, R. S., *Curr. Sci.*, 1967, **36** (17), 470.
5. Fukumoto, K., *Jap. J, Bot.*, 1962, **18** (1), 19.
6 Raghuvanshi, S. S. and Joshi, S., *Biol. Plant.*, 1965. **7** (3), 19[illegible].

FIXATION OF ELEMENTARY NITROGEN BY *SCYTONEMA GEITLERI* BHARADWAJA IN PURE AND UNIALGAL CULTURES

FIXATION of elementary nitrogen by a large number of blue-green algae has now been definitely established. In recent years, there have been many additions in the list of nitrogen fixing species of blue-green algae and now about 40 species belonging to 15 genera are reported to possess this characteristic (Pandey, 1966). This note is to record the fixation of nitrogen in *Scytonema geitleri* Bharadwaja which has not been investigated previously. The alga was isolated from the paddy field soils of Patna (India) and was secured in pure bacteria-free culture by using ultra-violet irradiation and streaking on silica gel plates impregnated with nitrogen-free nutrient solution (Gerloff *et al.*, 1950 and Watanabe, 1951). Purity of the alga was tested with usual bacteriological media, *viz.*, peptone solution (1%); mixture of glucose (0·5%) and peptone (1%) solutions; meat extract ("Oxo Lablemco) solution (1%) and De's (1939) medium containing glucose (0·5%). Absence of turbidity in all the replicates for about three weeks was taken as a criterion for the absence of bacteria. Tests for bacteria-free condition were also carried out just before and after the experiments.

The unialgal and pure cultures of *S. geitleri* were inoculated in 250 ml Erlenmeyer pyrex flasks containing 100 ml De's (1939) liquid medium which was made nitrogen-free by omitting the nitrogenous salt from the medium and adding Hutner's (1950) micro-nutrient solution in which $(NH_4)_6 Mo_7 O_{24}$ was replaced by MoO_3. The pH of solution was adjusted to 7·0. The cultures were grown under continuous light (180 lux) at 28–30° C and were harvested after 40 days of growth. The algal mat was separated by centrifugation. The nitrogen was estimated in both the supernatant and algal mat using Humphries' (1956) micro

Kjeldahl method. The dry weight of the algal mat was taken by filtration through pre-weighed Whatman filter-paper (No. 42) and drying in oven.

It is evident from the results shown in Table I, that *S. geitleri* is a nitrogen-fixing species. The dry weight and total nitrogen fixed by the unialgal culture are more as compared with values obtained from the pure culture. However, nitrogen fixed as per cent of dry weight is less in unialgal than in pure culture. The dry weight of unialgal mat also includes bacteria and hence probably there is lower percentage of fixed nitrogen. Such a condition where there is an increased fixation of nitrogen by the alga in association with bacteria (non-nitrogen fixer) has been recorded by other workers as well (Bunt, 1961; Bjälfve, 1962).

TABLE I

Showing amount of nitrogen (in mg) fixed in 40 days in pure and unialgal cultures of Scytonema geitleri *Bharadwaja in 100 ml culture solution*

	Dry weight	Nitrogen in algal mat less in inoculum	Nitrogen in filtrate	Total nitrogen	Nitrogen fixed per cent of dry weight
Pure culture ..	18·66	1·363	·818	2·101	11·25
Unialgal culture ..	24·10	1·574	·999	2·573	10·67

Fuller *et al.* (1960) have reported nitrogen fixation in *S. hofmanni* and *S. archangelli* and the percentage of nitrogen fixed per dry weight was 5·7 and 9·9 respectively. *S. bohneri* and another strain of *S. hofmanni* were reported to have fixed 3·89% and 4·98% of nitrogen per dry weight of the alga respectively (Laloraya and Mitra, 1964, 1970). Among the species of *Scytonema* investigated so far *S. geitleri* appears to be stronger nitrogen fixer as it is evident that in pure cultures it fixed 11·25% nitrogen per dry weight of the alga. Recently, Laloraya and Mitra (1970) found an increased fixation of nitrogen, *i.e.*, 12·05% nitrogen per dry weight of the alga in *Nostoc punctiforme*.

The author is grateful to Dr. A. K. Mitra and Dr. D. C. Pandey for suggestion and kindly reading the manuscript critically.

Botany Department, G. L. TIWARI.
Allahabad University,
Allahabad-2, *February* 5, 1971.

1. Bjälfve, G., *Physiologia Plantarum*, 1962, **15**, 122.
2. Bunt, J. S., *Nature*, 1961, **192** (4809), 1274.
3. De, P. K., *Proc. Roy. Soc. London*, Ser. *B*, 1939, **127**, 124.
4. Fuller, W. H., Cameron, R. E. and Nicholas Roica, Jr., *7th International Congress of Soil Science*, Madison, Wisc., U.S.A., 1960, **3** (22), 617.
5. Gerloff, G. C., Fitzgerald, G. P. and Skoog, F., *Amer. J. Bot.*, 1950, **37**, 216.
6. Humphries, E. C., *Modern Methods of Plant Analysis*, (Ed.) Peach, K. and Tracey, M. V., Springer Verlag, Berlin, 1956, **1**, 468.
7. Hunter, S. L., Provasoli, A. S. and Haskins, C. P., *Proc. Amer. Phil. Soc.*, 1950, **94**, 152. From Stein, J. R., *Amer. J. Bot.*, 1958, **45**, 664.
8. Laloraya, V. K. and Mitra, A. K., *Curr. Sci.*, 1964, **33**, 619.
9. — and —, *Experientia*, 1970, **26**, 106.
10. Pandey, D. C., *University of Allahabad Studies* (*Bot. Sec.*), Senate House, Allahabad, India, 1966, p. 1.
11. Watanabe, A., *Arch. Biochem. Biophys.*, 1951, **34**, 50.

INTERNATIONAL SYMPOSIUM ON MACROMOLECULES

THE IUPAC International Symposium on Macromolecules will be held in Helsinki, July 2-8, 1972.

The programme has been planned to include the following topics: (1) Polymerization and Copolymerization Reactions; (2) Solution Properties and Characterization Methods of Polymers; (3) Bulk Properties of Polymers; (4) Degradation and Decomposition of Polymers; (5) Polysaccharides and Their Derivatives.

Authors of all papers are requested to forward an abstract of not more than 250 words to the Programme Committee by September 1, 1971.

Inquiries and other correspondence concerning the Symposium should be addressed to: Dr. J. Larinkari, The Federation of Finnish Chemical Industry, P.O. Box 13028, 00130 Helsinki 13, Finland (Phone: 10300; Cable: Chemcongress).

REVIEWS AND NOTICES OF BOOKS

Annual Review of Nuclear Science, Vol. 20. (Annual Reviews, Inc., 4139, El Camino-way, Palo Alto, California 94306), 1970. Pp. vii + 613. Price $ 10.00 in U.S.A.; $ 10.50 elsewhere.

The present volume of the *Nuclear Science Annual Review*, No. 20, 1970, contains 13 review articles which cover a range of topics, both theoretical and experimental. The present status of quantum electrodynamics is discussed by S. J. Brodsky and S. D. Drell. Controlled fusion research and high temperature plasmas is the subject of the review article by R. F. Post. In Fast Breeder Reactors, Hafele *et al.* review the latest advances in fast breeder development.

Although it remains a dubitable point if quarks do exist or not, the subject continues to be a matter of interest in nuclear science research. Quarks are sought in accelerator experiments and in cosmic rays. Even there are searches for these fractionary charges in terrestrial materials. G. Morpurgo presents a short guide to the quark model giving a historical background and its present status with special reference to the non-relativistic quark model.

Peaceful uses of atomic energy has enlarged the field of activity in the non-military application of nuclear explosions both in technology and science. Among these are excavation, mining, and natural-gas stimulation. Of scientific applications of nuclear explosions meteorology and seismology have received large attention. B. C. Divan reviews in a short article, "Nuclear Explosions as a Nuclear Physics Tool".

High energy physics has focussed attention on automatic spark chambers, and their development opens up a new field of technological research. G. Charpak reviews the evolution of the automatic spark chambers with special reference to proportional multiwire chambers in operation at CERN.

M. M. Shapiro and R. Silberberg contribute a review article on Heavy Cosmic Ray Nuclei. The heavy primary nuclei (HPN) are those cosmic ray particles with atomic number Z $\geqslant$ 3. Any theories of the origin and propagation of cosmic rays, besides accounting for the observed properties of the two principal primary components hydrogen and helium (and
isotopes), must also confront the rich
of information one obtains regarding th
The authors summarize the so far well-
lished results on this aspect of cosm
research.

The other articles in this volume are:
tron Capture Gamma-Ray Spectroscop
H. T. Motz; Low-Energy Photonuclear
actions, by F. W. K. Firk; Alpha-P
Transfer Reactions, by Klaus Bethge; Pa
of Exchange Degeneracies, by J. Mand
Weyers and G. Zweig; Chemical Inform
from Photoelectron and Conversion-El
Spectroscopy, by J. M. Hollander and
Shirley; and Pionic Atoms, by G. Back

A. S.

Physics of Crystalline Dielectrics. By
Zheludev.

(Vol. 1)—*Crystallography and Sponta*
Polarization. Pp. 1-336. Price $ 25.00.

(Vol. 2)—*Electrical Properties.* Pp. 33
Price $ 25.00. (Plenum Publishing Corpor
114, Fifth Avenue, New York, N.Y. 1
U.S.A.).

Advancement in solid-state physics in ge
and the physics of dielectrics in particula
been very rapid during the past two de
especially as a result of the discovery of f
electrics which had added a new dime
to this research. The physics of crysta
dielectrics deals with all the phenomena
properties which are related in some wa
the electric polarization of crystals.
present two-volume publication is intend
cover the progress so far made in this p
cular aspect of research in crystal phy
While this treatise reviews work done on
subject throughout the world, understan
emphasis is on investigations carried ou
the USSR in the author's laboratory at
Institute of Crystallography.

The book is the outgrowth of lecture co
given by the author in the last decad
research workers and postgraduate studen
universities and at the Indian Institut
Science, Bangalore.

The material in the first volume of
treatise concerns crystallography and s
taneous polarization and is dealt with in

chapters. The first chapter deals with the fundamentals of symmetry and physical crystallography. Chapters II and III are concerned with investigations of the structure of ferroelectrics and antiferroelectrics. Spontaneous polarization domains and their behaviour as a function of temperature is the subject-matter of the fourth chapter. Chapter V deals with pyroelectric effect and associated phenomena. The last chapter discusses the theory of spontaneous polarization.

In Volume 2 the information presented in Volume 1 on the crystallography and structure of crystals is used to provide a comprehensive description of the electrical properties of dielectrics. The three chapters in this volume deal with Electric Polarization (Chapter VII), Electrical Conduction and Dielectric Losses (Chapter VIII), and Pizoelectric and Electrostrictive Properties (Chapter IX).

This uptodate and authoritative treatise on crystalline dielectrics should serve as a source of information for solid-state physicists, electrical engineers and materials scientists.

A. S. G.

Mineral Economics. By R. K. Sinha and N. L. Sharma. (Oxford & IBH Publishing Co., New Delhi-1), 1970. Pp. 308. Price Rs. 18·00.

One of the serious draw-backs in geological education and training in our country is the absence of text-books on different aspects of its geology and mineral resources. We had hoped that the authors of the book *Mineral Economics* writing primarily for readers in India would have devoted greater attention to mineral resources of India and the various problems attendant on their exploration and development. Instead, they have attempted to deal with the subject in a very general way undertaking a world review of mineral resources and mining legislation which, for obvious reasons, has been very sketchy and not quite informative. However, the book brings together a wealth of information relating to tenor, grade and specification of ores, methods of estimating reserves, and processes employed in mineral dressing which should prove useful to the student taking his first lessons in mineral economics. There is an informative chapter at the end of the book on growth of mineral industry.

In a book of this kind proper classification of data and presentation of information under suitable headings is essential. Serious attention does not appear to have been bestowed to this aspect. There is no uniformity in choosing paragraph headings. For example, bold headings are used only for copper and aluminium, while for iron and steel, coal and oil, headings are shifted to the side and printed in italics. Information relating to mineral-based industries in India, mineral self-sufficiency, extent of import of essential minerals, and the growing volume of export trade is hard to find for want of proper classification. A chapter on the mineral resource potential of the different States of the Indian Union would have been useful. We trust that these suggestions will be taken note of at the time of revision. The book is neatly got up though the standard of line drawings is poor. The book is priced Rs. 18 and is reasonable.

B. P. R.

Books Received

Laterite Genesis Location Use. By B. S. Persons. (Plenum Pub. Corpn., New York), 1970. Pp. xiv + 103. Price $ 9.50.

IR Theory and Practice of Infrared Spectroscopy. By N. L. Alper, W. E. Keiser and H. A. Szymanski. (Plenum Pub. Corpn., New York), 1970. Pp. xiv + 380. Price $ 18.50.

Low-Frequency Vibrations of Inorganic and Co-ordination Compounds. By J. R. Ferraro. (Plenum Pub. Corpn., New York), 1971. Pp. xiv + 309. Price $ 18.50.

Modelling of Sound Propagation in the Sea. By A. N. Barkhaton. (Plenum Pub. Corpn., New York), 1971. Pp. vii + 91. Price $ 15.00.

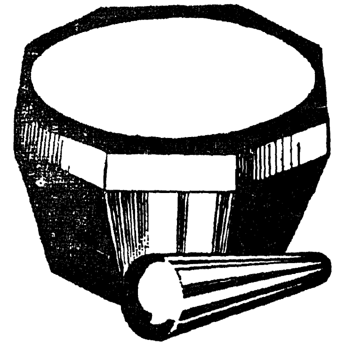
Modern Aspects of Solid-State Chemistry. Edited by C. N. R. Rao. (Plenum Pub. Corpn., New York), 1971. Pp. xiii + 626. Price $ 27.50.

Mossbauer Effect Data Index. (Covering the 1969 Literature). Edited by J. G. Stevens and V. E. Stevens. (Plenum Pub. Corpn., New York), 1971. Pp. xxxvi + 281. Price $ 24.00.

Non-Linear Effects in Plasma. By V. N. Tsytovich. (Plenum Pub. Corpn., New York), 1970. Pp. xviii + 332. Price $ 25.00.

Nuclear Physics and Interaction of Particles with Matter. By Acad D. V. Skobeltsyn. (Plenum Pub. Corpn., New York), 1971. Pp. vii + 269. Price $ 32.50.

2845-71. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.



AGATE MORTERS & PESTLES

(Grade A1)

Absolutely and totally flawless quality both internally and externally. (These Agate Mortars & Pestles are being exported to very well-known users and trade houses in U.K., U.S.A., Japan & all other countries of the world.)

Sizes available from 20 mm. to 200 mm. diameter.

Also available all types of IP THERMOMETERS for the Petroleum Testing Laboratories.

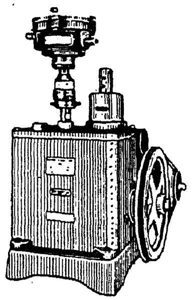
Please contact :

LABORATORY FURNISHERS
Dhun Mansion, 186 C, Vincent Road, Dadar, BOMBAY-14

Phone : 442761
Telegrams : LABFURNISH
Branch Office : KAPASIA BAZAR, AHMEDABAD 2

SP/lab/7

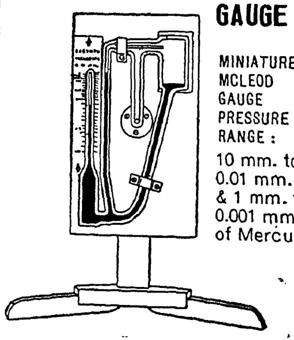
THE 'FINE FOUR' IN **'BASYNTH'** RANGE !



ROTARY VACUUM PUMPS
OIL SEALED TYPE

ANALYTICAL REAGENT
500 Grms
AMMONIUM NITRATE

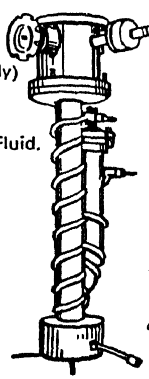
GUARANTEED ANALYTICAL REAGENT CHEMICALS
conforming to Internationally accepted specifications



VACUUM measuring GAUGE
MINIATURE MCLEOD GAUGE PRESSURE RANGE :
10 mm. to 0.01 mm. & 1 mm. to 0.001 mm. of Mercury.

OIL DIFFUSION PUMP
with Baffle Valve, By-pass Valves etc.
(All-metal Body)
VACUUM : 10^{-5} mm. Hg. with Basynth Fluid.
SPEED : 50 Litres/Sec. or more.

100% INDIAN



Progressive/BSC-24

MANUFACTURED BY :
BASIC & SYNTHETIC CHEMICALS PRIVATE LTD.
25, EAST ROAD, JADAVPUR, CALCUTTA-32.

CHEMICO-GENETIC STUDIES OF LEUCOANTHOCYANIDIN IN A MAIZE MUTANT

A. R. REDDY AND G. M. REDDY

Department of Genetics, Osmania University, Hyderabad-7 (A.P.), India

ABSTRACT

The nature of the accumulated substance in a_2 mutant aleurone was studied in relation to the known gene action order for anthocyanin biosynthesis in maize. Spectrophotometric, chromatographic, and chemical studies clearly suggest that the accumulated substance in a_2 mutant is leucocyanidin (5, 7, 3′, 4′-tetrahydroxy flavon : 3, 4 diol). The biogenetic relationship of leucoanthocyanidin to anthocyanin is discussed in the light of the gene-controlled chemical pathway.

IDENTIFICATION of gene-controlled end products has opened new avenues for speculation and experimentation concerning the nature and mode of gene action. This is specially true when contrasting genotypes produce different and easily identifiable substances in an organism. The genetic system of anthocyanin biosynthesis in maize, which is controlled by more than ten genes, is one of the best known examples in higher organisms wherein the biochemical basis of gene action can be analysed.

In maize, the anthocyanin synthesis in aleurone tissue, the outermost layer of endosperm, is controlled by the complementary factors C_1, C_2, A_1, A_2 and R. The dominant inhibitor gene C^I blocks the synthesis whereas the intensifier (In), bronze-1(Bz_1) and bronze-2(Bz_2) control the intensity of anthocyanin: Pr/pr controls the hydroxylation pattern.[1] Reddy and Coe[2] (1962) proposed the following gene action sequence for anthocyanin synthesis using inter-tissue complementation technique with fresh, synthetically-active and genetically-blocked mutant alurone tissue.

C^I C_1 C_2 R In A_1 A_2 Bz_1 Bz_2-Anthocyanin
→ → → → → → → → →

However, the specific information regarding the chemical nature of intermediates associated with the specific genes in the above gene action sequence is not yet fully available. Coe[3] (1955) has reported the accumulation of a colourless substance in aleurone tissue of a_2 mutant, which upon heating with acid gave coloured anthocyanidin. It has been also stated that the homozygous recessive intensifier (in) enhanced the production of this colourless substance, *i.e.*, leucoanthocyanidin by about 10-15 folds in a_2 mutant. Earlier studies have clearly shown that the genes, C_1, C_2, A_1 and R preceding a_2 in the gene action sequence must be present in dominant condition at least in one dose, for the production of leucoanthocyanidin in a_2 mutant.[4] The presence of dominant inhibitor C^I blocks synthesis and Pr/pr controls the hydroxylation of leucoanthocyanidin. The present work deals with the nature of the substance accumulated in a_2 mutant aleurone tissue and the specific role of A_2/a_2 gene in anthocyanin biosynthesis.

MATERIALS AND METHODS

Dry mature kernels of a_2 mutant (C_1 C_2 R In A_1 a_2 Bz_1 Bz_2 Pr) and double mutant *in* a_2 (C_1 C_2 R A_1 *in* a_2 Bz_1 Bz_2 Pr), after removal of pericarp, are defatted with petroleum ether (40-60°) for 24 hours and then extracted with cold methanol. After 36 hours, the solvent was removed under reduced pressure on a rotary evaporator and treated with cold ether. Ether insolubles are separated and treated with a small amount of water. The aqueous solution was repeatedly extracted with pure ethyl acetate in a separating funnel. The combined ethyl acetate extract was dried over anhydrous magnesium sulphate. The solvent was removed on a rotary evaporator and a light brown amorphous residue of the substance was obtained. The extracted substance was converted to the corresponding flavylium chloride by boiling with 5% methanolic-2 N hydrochloric acid for 30 min on a steam-bath. The pink solution was extracted repeatedly with isoamyl alcohol. The combined isoamyl alcohol extracts were used for further studies.

Paper chromatography with two different solvent systems BAW (n-butanol 4 : acetic acid 1 : water 5) and Forestal (acetic acid 30 : HCl 3 : water 10) on Whatman No. 1 paper was used throughout the investigation. Extracts were kept in the dark during all stages of isolation. The following five techniques were used for the identification of the isolated compound and its flavylium chloride : (1) R_f values ; (2) Visible colours ; (3) Colour reactions ; (4) Reactions to various specific spraying reagents ; (5) Absorption spectra. The pure sample was co-chromatographed with the extracts for comparison. The chromatographically pure isolated compound and the converted flavylium chloride were taken in methanol and in 5% methanolic hydrochloric acid solution respectively and were subjected to Beckman DB spectrophotometer and readings were taken at intervals of 5 mμ in the UV region of 200-300 mμ and also in the region of 220-560 mμ.

OBSERVATIONS AND DISCUSSION

The average R_f values and absorption maxima of converted anthocyanidins along with pure cyanidin chloride are presented in Table I. The chromatograms (circular) of the isolated compound when sprayed with different specific spraying reagents (and heated for 30 min at 80° C in a hot air-oven whenever it was necessary) gave the following: (*a*) characteristic green colours with ferric reagent; (*b*) positive reaction to ammoniacal silver nitrate solution; (*c*) intense violet-red colours with vaniline-toluene-*p*-sulphonic acid; (*d*) purple colouration with 10% sulphuric acid. It was soluble in water, ethylacetate and insoluble in ether. When subjected to various characteristic chemical reactions, it gave the following: (*a*) dark green colouration with neutral ferric chloride, (*b*) positive reaction to aqueous sodium hydroxide (fresh) and sulphuric acid, (*c*) pink colouration with hydrochloric acid on heating for a few minutes on steam-bath, (*d*) negative reaction to Mollish test for carbohydrates, hence an aglycone, (*e*) absorption maxima at 286 mμ.

The converted anthocyanidin was fairly stable and gave positive reactions to the various above-mentioned specific spraying reagents. In addition, it gave the characteristic R_f values and absorption maxima (*see* Table I) and also showed the positive reaction to cyanidin reagent.

The chromatographic, spectrophotometric and chemical studies suggest that the isolated compound is leucocyanidin or 5, 7, 3′, 4′-tetrahydroxy flavan : 3, 4 diol. The exact role of leucoanthocyanidin in anthocyanin biosynthesis is not yet clear. Chemico-genetic studies with flower petals of Impatiens suggested a close relationship between the leucoanthocyanin and anthocyanin biosynthesis.[5] Later studies with seed coats of Phaseolus[6] and more recently labelled studies using phenylalanine-1-C^{14} with Impatiens[7] lead to the conclusion that both leucoanthocyanin and anthocyanin are synthesised by parallel biosynthetic pathways.

The double recessive combinations of a_2 bz_1, a_2 bz_2 and *in* a_2 in the gene action sequence accumulate leucoanthocyanidin whereas it was absent in double mutants of C^I a_2, c_1 a_2, c_2 a_2, r a_2 and a_1 a_2 alerone suggesting that bz_1, bz_2 and *in* do not interfere with the synthesis of leucocyanidin whilst the C^I and recessive c_1, c_2, r and a_1 block it.[4] Though *Pr*/*pr* controls the hydroxylation pattern of the leucoanthocyanidin and anthocyanidin its exact position in the known gene action sequence was not clear. The studies on the accumulated substance in the double mutants of a_1 *Pr* (quercetin), and a_1 *pr* (Kaempferol) and a_2 *Pr* (leucocyanidin) and a_2 *pr* (leucopelargonidin) suggest that *Pr*/*pr* acts prior to A_1 and A_2 in the known gene action sequence.[8] These observations emphasise a common biosynthetic pathway for leucoanthocyanidin and anthocyanin (*see* Fig. 1).

If leucocyanidin is a precursor in anthocyanin biosynthesis, then at least two steps such as chromogenation and glycosidation are necessary for conversion of leucocyanidin to

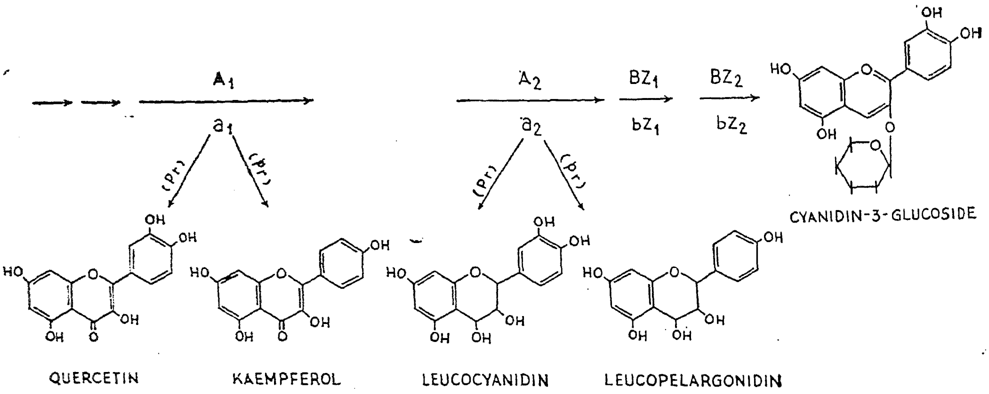


FIG. 1. Gene-controlled chemical pathway of anthocyanin synthesis in maize.

TABLE I

The R_f values and absorption maxima of the converted anthocyanidin and pure cyanidin chloride

Genotype	R_f values		Absorption maxima in mμ	
	Baw	Forestal	UV	Visible
a_2 ..	0·68	0·48	279	541
in a_2 ..	0·68	0·47	278	542
Cyanidin chloride	0·69	0·49	279	543

anthocyanin. In the known gene action sequence, there are only three genes A_2, Bz_1 and Bz_2 which may convert leucocyanidin to anthocyanin. The A_2/a_2 gene could act in two different ways, either by direct conversion of leucocyanidin to cyanidin or on a common precursor in the biosynthesis of these pigments. The glycosidation of quercetin to its 3-glycoside (isoquercetin) by an enzyme from Bz_1 pollen extracts suggests indirectly that this gene might control the glycosidation of anthocyanin molecule.[9] Further studies on isolation and characterisation of gene-controlled intermediates in anthocyanin biosynthesis, in maize, may unravel the mechanism of gene action at chemical level.

ACKNOWLEDGEMENTS

The authors thank Professor O. S. Reddi, Head, Department of Genetics, Professor N. V. Subba Rao, Head, Department of Chemistry, Osmania University, for providing facilities, and the Department of Atomic Energy for the grant to carry out this work.

---

1. Coe, E. H., *American Naturalist*, 1957, **91**, 381.
2. Reddy. G. M. and Coe, E. H., *Science*, 1962, **138**, 149.
3. Coe, E H., *Genetics*, 1955, **40**, 568 (Abstr.).
4. Reddy, G. M., *Ibid.*, 1964, **50**, 485.
5. Alston, R E. and Hagen, C. W., Jr., *Nature*, 1955, **175**, 990.
6. Feenstra, W. J., *Landbouwhogeschool*, 1960, **60** (2), 1.
7. Wolfgang Wille, *Z. Planzenphysiol.*, 1967, **57** (2), 134.
8. Kirby, L. T. and Styles, E. D., *Can. Jour. of Genetics and Cytology*, 1970, **12** (4), 934.
9. Larson. R, L. and Coe, E. H., *XII International Congress of Genetics*, 1968, **1**, 131 (Abstr.).

IN VITRO GROWTH REQUIREMENTS OF MATURE ENDOSPERM OF *RICINUS COMMUNIS*

P. S. SRIVASTAVA

Department of Botany, University of Delhi, Delhi-7

SATSANGI and Mohan Ram (1965) succeeded in inducing embryoid formation in the callus of mature endosperm of *Ricinus communis*, but failed to obtain organogenesis. The present investigation was undertaken (*a*) to ascertain the growth requirements, and (*b*) to explore the possibility of induction of root and shoot.

Ripe fruits were collected from the Delhi University Campus. After removal of the fruit-wall and seedcoat, the mature endosperm (with embryo intact) was washed with 'cetavlon' (cetrimide concentrate, diluted to 100 times) and surface-sterilized with chlorine water for 10-12 min. The endosperm was then washed with sterile distilled water and soaked in it for 24 hr. This was then implanted aseptically on modified White's semi-solid (agar 0·8%) medium containing 2% sucrose (WB). The supplements used were: indoleacetic acid (IAA), indolebutyric acid (IBA), indolepropionic acid (IPA), naphthaleneacetic acid (NAA), phenoxyacetic acid (PAA), 2, 4-dichlorophenoxy acetic acid (2, 4-D), 2, 4, 5-trichlorophenoxyacetic acid (2, 4, 5-T), adenine (AD), adenine sulphate ($ADSO_4$), kinetin (KN), benzyladenine (BA), diphenyl urea (D P U), 6-(γ, γ-dimethylallylamino)-purine (6-γ, γ), SD 8339, triacanthine (TA), zeatin (ZN), myo-inositol, casein hydrolysate (CH), coconut milk (CM), and yeast extract (YE). The effect of various sugars was also tested.

On WB alone, WB + IAA, WB + IBA, WB + IPA, WB + NAA, or WB + KN, after six weeks, in 80% cultures, the embryo developed into a normal seedling (Fig. 1, A). However, on WB + 2, 4-D, germination of the embryo was delayed and swelling of the radicle was observed after 3 weeks. The endosperm showed only slight swelling and cracks but did not callus. On WB + 2, 4-D (2 ppm) + KN (5 ppm) + YE (2,500 ppm), germination of the embryo was altogether suppressed, and the radicle callused. Along the surface in contact with the embryo, the endosperm also proliferated forming a white, fluffy callus (Fig. 1, B). In subcultures maintained on the same medium, the endosperm callus showed satisfactory growth and became compact after four passages (each passage of four weeks) (Fig. 1, C).

Squash preparations of a 4-week-old endosperm callus revealed thin-walled cells of different shape and size, while a 10-week-old callus showed tracheid-like cells with reticulate thickenings. The sections (12-15 μ thick) of a 12-week-old compact callus exhibited a peripheral zone of cambium-like cells followed by thick-walled cells simulating vascular bundles (Fig. 1, D).

In one set of experiments different concentrations of sucrose ($0 \cdot 3 \times 10^{-1}$ M to $3 \cdot 5 \times 10^{-1}$ M) were used, and fresh and dry weight recorded after six weeks. 10^{-1} M produced best growth of callus.

In another set of experiments, sucrose was replaced by glucose, fructose, maltose, raffinose, arabinose, sorbose, galactose, lactose, mannose and cellobiose (all at equimolar concentration of 10^{-1} M). Sucrose, glucose, fructose and maltose were almost equally effective in bringing about both fresh and dry weight

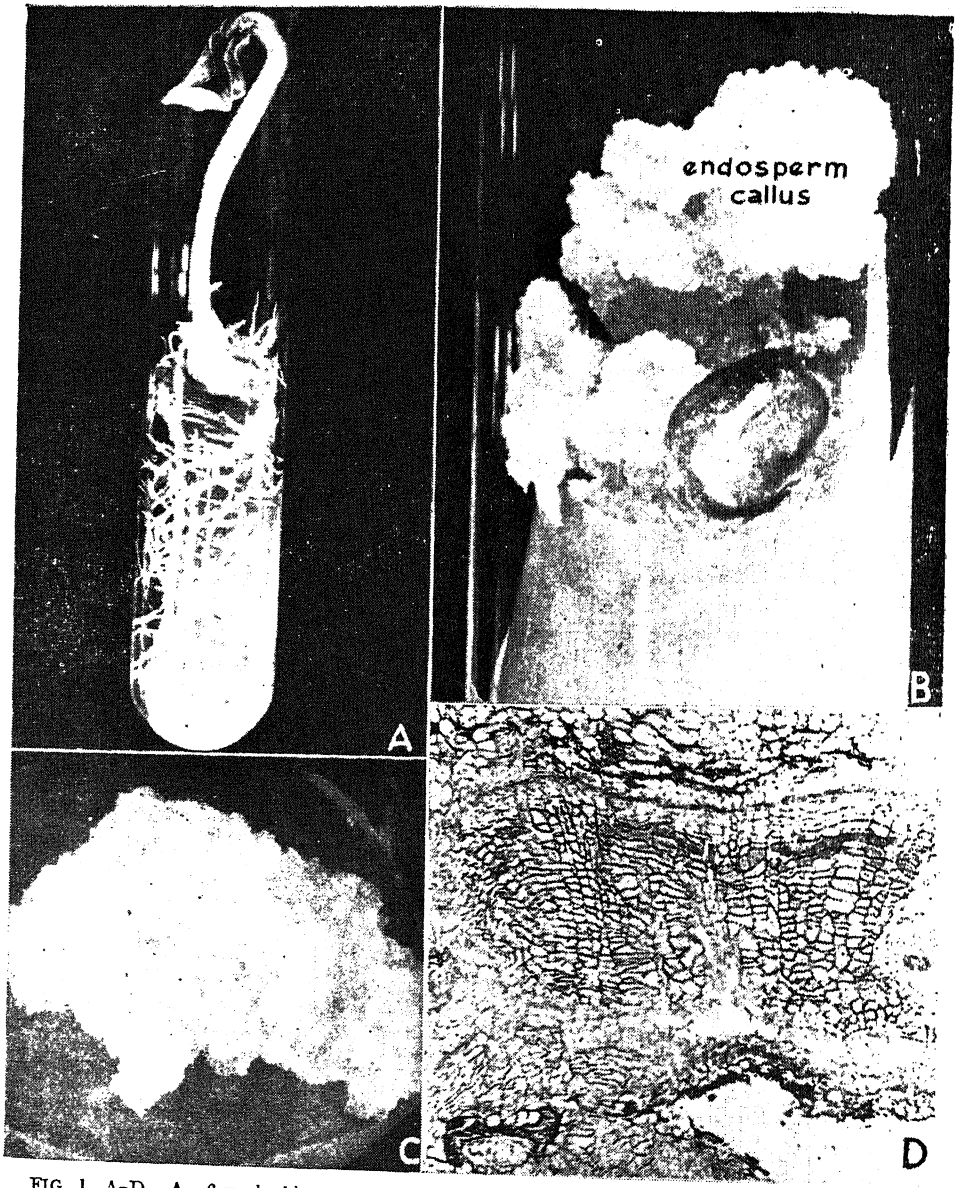


FIG. 1, A–D. A. 6-week old normal seedling on WB, × 1; B. Callused endosperm and collapsed cotyledons in a 8-week-old culture on WB + 2, 4-D + KN + YE, × 2·5; C. Compact endosperm callus (medium same as for B, × 2). D. Vascular bundle-like structure, × 130.

increases of callus. These results are summarized in Table I.

TABLE I

Growth of callus on WB with different supplements

Medium	Concentration	% Increase	
		Fresh weight*	Dry weight*
WB+sucrose (control) ..	10^{-1} M	1,360	375
WB+mannose ..	10^{-1} M	145	28
WB+2, 4 D ..	10^{-5} M	1,360	430
WB+2, 4, 5-T .	10^{-5} M	695	185
WB+SD 8339 ..	$2 \cdot 5 \times 10^{-5}$ M	1,425	470
WB+DPU ..	$2 \cdot 5 \times 10^{-5}$ M	470	140
WB+YE ..	3,000 ppm	1,425	385

* Average of 48 cultures; growth period 6 weeks.

Of PAA, 2, 4-D and 2, 4, 5-T, at equimolar concentration of 10^{-1} M, 2, 4-D was most effective.

Of SD 8339, KN, BA, 6-γ, γ; ZN, AD, TA and DPU, optimal increase of fresh and dry weight occurred with SD 8339, KN and ZN. DPU was least effective.

Recently, the author isolated a white, fragile nodulated callus from the endosperm tissue grown on WB + 2, 4-D + KN + YE. This has been successfully subcultured on WB + CH (1,000 ppm).

Thus, the mature endosperm tissue of *Ricinus communis* can be stimulated to divide and form a continuously-growing callus. All efforts to induce organogenesis in callused endosperm have not yet succeeded, and further studies in this direction are in progress.

I am indebted to Professor B. M. Johri for guidance.

---

1. Satsangi, Asha and Mohan Ram, H. Y., *Phytomorphology*, 1965, **15**, 26.

THE SYSTEMATIC POSITION AND OCCURRENCE OF *PARIOGLOSSUS* (TELEOSTEI : GOBIOIDEA) IN INDIAN WATERS

P. J. MILLER

Zoology Department, The University, Bristol, BS 8 1 UG, England

THE marine gobioid genus *Parioglossus* Regan 1912[1] (syn. *Herrea* Smith, 1931,[2] not *Herrea* Whitley, 1930,[3] replaced by *Herreolus* Smith, 1931[4]) is of widespread Indo-West Pacific distribution, and comprises four tiny species, the type *P. taeniatus* Regan 1912, originally described from Aldabra,[1] *P. rainfordi* McCulloch, 1921 (Bowen, Queensland[5]), *P. borneensis* Koumans, 1953 (Balikpapan, Borneo[6]), and *P. dotui* Tomiyama, 1958 (SW Japan[7]), the last reaching the maximum size of 37 mm[8] recorded for the genus. *Parioglossus* has been reviewed by Tomiyama,[9] who provides a key and illustrations of these species.

Because of its separate pelvic fins, *Parioglossus* has been placed in the family Eleotridae of the suborder Gobioidea (Regan,[10] Koumans[6]), whose largest family, the Gobiidae, is traditionally characterised by the possession of a shallow ventral disc formed by fusion of the pelvic fins. Although a classification of gobioid fishes based on their osteology was proposed many years ago by Regan,[10] and has been subsequently amplified (Gosline,[11] Hoese[12]), most representatives of the suborder await comprehensive skeletal investigation and, consequently, in several important monographs, have been arranged by external features (Herre,[13] Koumans,[6,14] Smith,[15] etc.).

Recently, the present author has examined alizarin preparations (Fig. 1) and radiographs of the skeleton in *Parioglossus*. While certainly gobioid, with unossified suspensorial foramen (bounded by symplectic, quadrate, and preopercular), and upper (epaxial) and lower (hypaxial) caudal radials, the genus was found however to be gobiid rather than eleotrid in structure. Typical gobiid features displayed are the single pterygoid element in the palatoquadrate arch, markedly T-shaped palatine head, reduced hypercoracoid, five branchiostegous rays, and only one epural plate in the caudal skeleton. *Parioglossus* may thus be regarded as a gobiid specialised externally by secondary separation of the pelvic disc (a trend recorded in many others of the same family[16]) and with further modifications, such as incipient duplication of interspinous bones between neural and haemal spines, forward shifting of the jaw articulation by suspensorial elongation, etc., probably connected with its nektonic mode of life.[17,18] In all the latter features, *Parioglossus* shows affinity with *Ptereleotris* Gill, 1863, *Oxymetopon* Bleeker, 1861, *Ioglossus* Bean, 1882, and probably other genera, all larger free-swimming or burrow-dwelling gobiids with divided pelvic fins.[12,18,19] Another clue to relationships is afforded by the cephalic lateral-line canal system in *Parioglossus,* which is unusual among gobiids in possessing a separate interorbital canal on each side, with five (including two terminal) pores. These features, together with general habitus, meristic features and behaviour, all resemble those of the very recently described *Vomerogobius flavus* Gilbert, of tropical western Atlantic (Bahamas) occurrence.[20] The latter still shows union of the pelvic fins, although lacking an anterior pelvic membrane, and, at least in adult males, has vomerine teeth, which could not be detected in *Parioglossus.*

Among material studied were many *Parioglossus* from Ratnagiri (Maharashtra, India) and now deposited in the British Museum (Natural History), Reg. No. 1960.12.30.32-61. These examples belong to the same species as that recorded from Ratnagiri by Ranade and Sankolli[21] under the name of *P. taeniatus,* but agree exactly with Tomiyama's description of *P. dotui,* and their dissimilarity with the true *P. taeniatus* has been confirmed by examination of the type specimens of the latter [BM(NH) 1912.5.3.28-29]. Although somewhat faded, the colour pattern of these two types closely resembles that shown by Tomiyama for *P. taeniatus.* According to this author, *P. taeniatus* and *P. dotui* differ from the other pair of species in the possession of a dermal ridge along the dorsal midline of the nape and of contiguous dorsal fins. To identify these two species, *P. taeniatus* has a radial formula of D_2 I/13-14, A I/13-14 ; about 90 scales in lateral series ; markedly convex caudal fin ; and dark longitudinal bands on back, sides, and abdomen, with the upper and lateral ones continued on to the caudal fin (Tomiyama,[9] Fig. 3), while *P. dotui* is distinguished by D_2 I/15-18, A I/15-19 ; about 100 lateral scales ; truncate caudal fin ; and only dorsal and lateral bands, the latter forming a single short horizontal caudal mark along the proximal lateral midline of this fin (Tomiyama,[9] Fig. 4). In fact, the Ratnagiri *P. dotui* have radial formulae of D_2 I/16-17, A I/16-17 (counting the terminal bifid ray as one in both fins) while the two syntypes of *P. taeniatus* have radial formulae of D_2 I/16, A I/15 and D_2 I/15, A I/16, and well separated dorsal fins, so that these criteria have less value for species definition than Tomiyama supposed. The possibility must be borne in mind that all four nominal species may be colour phases of a single species, perhaps linked with sexual dimorphism in nuchal ridge and dorsal fin development. However, Dotu[8] found ripe adults of both sexes with the livery of *P. dotui* (as *P. taeniatus* ; Dotu, Fig. 1), the males showing a dark anal fin.

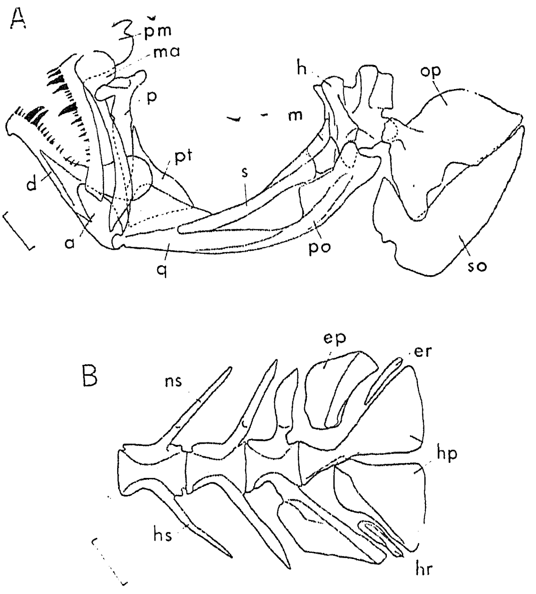


FIG. 1. Suspensorium and jaws (A), and caudal skeleton (B), in *Parioglossus dotui.* 27·5+5·0 and 24·5+4·5 mm respectively BMNH 1960.12.30. 32-61, part) from Ratnagiri, India. Abbreviations : *a*, articular ; *d*, dentary ; *ep*, epural plate ; *er*, epaxial radial ; *h*, hyomandibular ; *hp*, hypurals ; *hr*, hypaxial radial ; *hs*, haemal spine ; *m*, metapterygoid ; *ma*, maxilla ; *ns*, neural spine ; *op*, opercular ; *p*, palatine ; *pm*, premaxilla ; *po*, preopercular ; *pt*, pterygoid ; *q*, quadrate ; *s*, symplectic ; *so*, subopercular. Scale 0·5 mm.

Ranade and Sankolli[20] described the vivid life colouration of *P. dotui* (as *P. taeniatus*) and found the species 'common in the rock pools of brackish-water regions' of the Ratnagiri coast. The biology, including embryology and postlarval development, of this species (again as *P. taeniatus*) around the Japanese islands of Kyushu and Shikoku has been investigated by Dotu.[8] There, *P. dotui* is a gregarious inshore species, neritic at least during the day, and feeds on planktonic copepods. Breeding takes place from the beginning of July to September (Amakusa Islands, Kyushu). In the case of *P. taeniatus,* the original specimens were collected in the lagoon of Aldabra but, subsequently, intertidal occurrence is reported in the Gulf of Siam (as *Herrea formosa* Smith)[2] and the Philippines (as *Herreolus formosus*),[22] where, at Port Holland (Basilan), Herre observed that a shoal would swim at the surface until disturbed and then seek refuge in the fouling growth on a nearby piling. Since the area of distribution for *P. dotui* and *P. taeniatus*, is now known to be so extensive, it seems very likely that the latter, and other species of *Parioglossus*, will be recorded from Indian localities.

The author is indebted to Mr. A. C. Wheeler for arranging the loan and radiography of specimens of *Parioglossus* belonging to the British Museum (Natural History).

---

1. Regan. C. T., *Trans. Linn. Soc. Lond.*, 1912, **15**, 301.
2. Smith, H. M., *Proc. U. S. Nat. Mus.*, 1931, **79** (7), 48.
3. Whitley, G. P., *Austr. Zool.*, 1930, **6**, 117.
4. Smith, H M., *J. nat. Hist. Soc. Siam*, 1931, **8**, 177.
5. McCulloch, A. R., *Proc. Linn. Soc. N.S.W.*, 1921, **46**, 457.
6. Koumons, F. P., *The Fishes of Indo-Australian Archipelago*, 10, *Gobioidea*, 1953, p. 423.
7. Tomiyama, I., *Figures and Descriptions of the Fishes of Japan*, 1958, **57**, 1171.
8. Dotu, Y., *Sci. Bull. Fac. Agric. Kyushu Univ.*, 1956, **15**, 489.
9. Tomiyama, I., *Annot. Zool. Jap.*, 1959, **32** (2), 101.
10. Regan, C. T., *Ann. Mag. nat. Hist.*, (Ser. 8), 1911, **8**, 729.
11. Gosline, W. A., *Pacif. Sci.*, 1955, **9**, 158.
12. Hoese, D. F., *Abstr. Meet. Amer. Soc. Ichthyol, Herpetol.*, San Fransisco, 1967, p. 13.
13. Herre, A. W. C. T., *Monogr. Bur. Sci. Manila*, 1927, **23**, 352.
14. Koumans, F. P., *Mem. Ind. Mus.*, 1941, **13**, 205.
15. Smith, J. L. B., *Ichthyol. Bull. Rhodes Univ.*, 1958, No. 11, 137; 1959, No. 13, 185.
16. Miller. P. J and Tortonese, E., *Ann. Mus. civ. Stor. Nat. Genova*, 1968, **77**, 342.
17. Mironescu, I., *Rev. Rom. Biol. Zool.*, 1970, **15** (4), 247.
18. Miller, P. J., (unpublished).
19. Randall, J. E., *Ichthyologica*, 1967, **39**, 107.
20. Gilbert, C. R., *Copeia*, 1971, No. 1, 27.
21. Ranade, M. R. and Sankolli, K. N., *Curr. Sci.*, 1962, **31** (7), 289.
22. Herre, A. W. C. T., *Phil. J. Sci.*, 1940, **72** (4), 357.

ROTATIONAL ANALYSIS OF THE C_2 SYSTEM OF SbF MOLECULE

R. SHANKER AND I. S. SINGH

Spectroscopic Laboratory, Banaras Hindu University, Varanasi-5

THE emission spectrum of SbF molecule as investigated by earlier workers[1-5] is known to consist of three visible systems (A_1, A_2 and A_3) and four ultraviolet systems (B, C_1, C_2 and C_3). Patel and Abraham[4] have carried out detailed vibrational analysis of the C_2 and C_3 systems and concluded that both of these systems originate from a close lying upper triplet state. The vibrational frequencies of the two lowest known electronic states of this molecule are 609·0 and 612·6 cm^{-1}. The rotational analyses of the C_1 and C_3 band systems have been reported by Sivaji and Rao[5] and Patel and Abraham[6] respectively. However, the transition involved in the C_2 band system has not been confirmed so far from a study of rotational analysis.

The (0, 0) and (0, 1) bands of the C_2 system excited in a quartz hollow cathode discharge tube have been recorded in the third order of a 35 ft concave grating spectrograph having a dispersion of 0·22 A/mm. With a slit-width of 50 microns, an exposure of 10 hours was found sufficient to photograph the bands on Ilford Q-2 plates.

Examination of the (0, 0) band of the C_2 system (reproduced in Fig. 1) reveals the presence of three heads of which two are strong and the third is weak. If we treat the two strong heads as P and Q heads of the same band, we should expect for violet degraded bands the separation between these to be larger for the (0, 0) band than for the (0, 1) band. However, our measurements show this separation to be 3·45 cm^{-1} for the (0, 0) band and 3·65 cm^{-1} for the (0, 1) band. Furthermore, toward the shorter wavelength side of each strong head, there are two regions which give the appearance of band origins. This observation prompted us to treat the two strong heads as belonging to two sub-bands of the same band system. Since the bands are violet-degraded these heads are taken to be corresponding P heads of the two sub-bands. The Q head of the first sub-band appears to merge with the P head of the second sub-band or to be lying very close to it, whereas the Q head of the second sub-band lies very near to the origin of this component. In the second sub-band, there are two intense branches running almost parallel to each other up to high J values, which may be treated as Q and R branches. Also, a series of weak lines has been picked out as a head forming P branch. In addition, the rotational structure corresponding to the first sub-band dies out so rapidly after the head formation that no structure is observed for this component. These features indicate that this band system may originate from a close multiplet upper state. In the second sub-band lying on the shorter wavelength side of the first sub-band, P, Q and R branches have been picked out in both the (0, 0) and (0, 1) bands. The $\triangle_1 F'(J) = R(J) - Q(J)$ values for both the bands are found to be in very good agreement. No Λ-type doubling in the upper state could be detected as the combination defect is found to be negligibly small.

For $^3\Pi_i$ state belonging to purely case (*a*), Y, the strength of coupling of the spin to the internuclear axis, is expected to be several hundreds whereas for purely case (*b*), it should be very small (0 to 4). In the present case, $Y = A/B = -10$. Therefore, the close triplet state is considered to belong to an intermediate between case (*a*) and case (*b*).

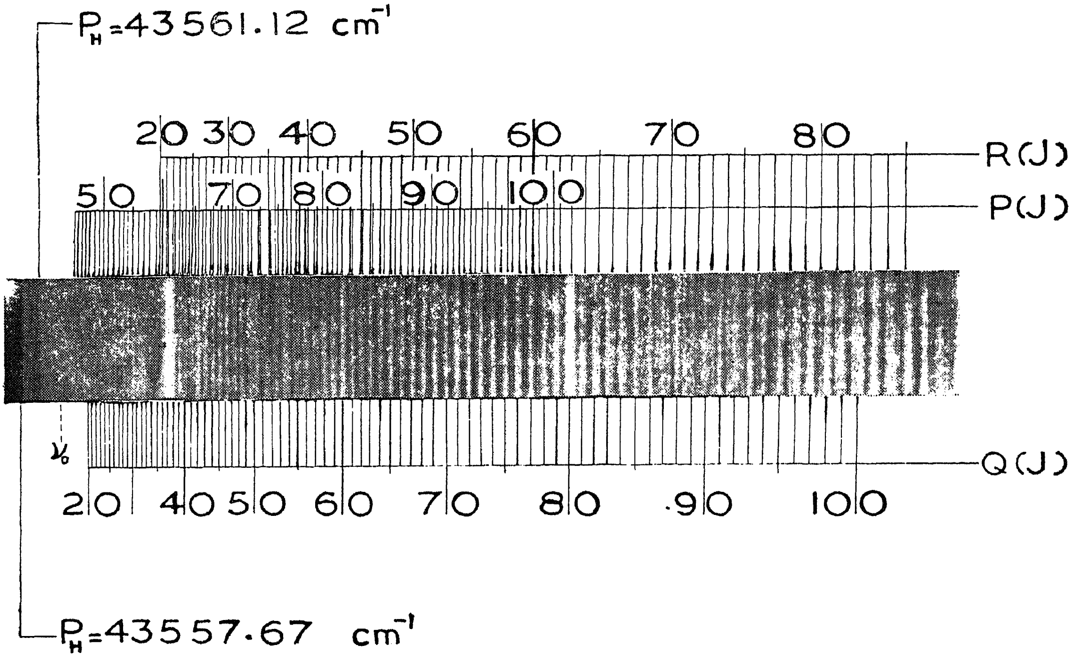


FIG. 1. (0, 0) band of C_2 system of SbF

The electronic configuration for the ground state of SbF molecule is :

$$\ldots\ldots\ldots (x\sigma)^2\ (w\pi)^4\ (v\pi)^2\ \ldots\ {}^3\Sigma\ \ {}^1\triangle_2,\ {}^1\Sigma$$

The excited state for the present band system is derived from :

$$\ldots\ldots\ldots (x\sigma)\ (w\pi)^4\ (v\pi)^3 \ldots\ldots\ {}^1\Pi,\ {}^3\Pi_i.$$

If we take $^3\Pi_i$ as the upper state and $^1\triangle_2$ as the lower state, the theoretically predicted structure agrees well with the observed spectrum of this band system. This transition gives rise to two components: $^3\Pi_2 - {}^1\triangle_2$ and $^3\Pi_1 - {}^1\triangle_2$ of which the first component is equivalent to Σ-Σ type and the second component to Π-Σ type transition. It is also observed that there is a slight diffuseness and splitting in the lines at the tail end of each band. This is probably due to the two isotopes of antimony Sb^{121} (56%) and Sb^{123} (44%). The vibrational isotopic shift is clearly seen in the sub-bands of the (0, 1) band and is found to be 0·80 cm^{-1} being in good agreement with the calculated value.

The rotational constants of the upper and lower states have been determined and are collected in Table I.

TABLE I

Rotational constants of the upper and lower states of the SbF molecule (2250-2450 A system)

$C_2\ {}^3\Pi_1$ state	$X_2\ {}^1\triangle_2$ state
$B_0' = 0\cdot3265$ cm^{-1}	$B_e'' = 0\cdot3095$ cm^{-1}
	$B_0'' = 0\cdot3085$ cm^{-1}
$A = -3\cdot37$ cm^{-1}	$B_1'' = 0\cdot3065$ cm^{-1}
$D_0' = 0\cdot42 \times 10^{-6}$ cm^{-1}	$\alpha_e'' = 0\cdot002$ cm^{-1}
$r_0' = 1\cdot77 \times 10^{-8}$ cm	$D_0'' = 0\cdot25 \times 10^{-6}$ cm^{-1}
$I_0' = 85\cdot7 \times 10^{-40}$ gm cm^2	$D_1'' = 0\cdot30 \times 10^{-6}$ cm^{-1}
	$\beta_e'' = 0\cdot05 \times 10^{-6}$ cm^{-1}
$\nu_{0,\,0} = 43566\cdot5$ cm^{-1}	$r_e'' = 1\cdot82 \times 10^{-8}$ cm
$\nu_{0,\,1} = 42959\cdot0$ cm^{-1}	$I_e'' = 90\cdot63 \times 10^{-40}$ gm cm^2

1 Rochester, G. D. *Phys. Rev.*, **1937**, **51**, 486.
2. Howell, H. G. and Rochester, G. D., *Proc. Phys. Soc.*, 1939, **51**, 329.
3. Rao P. and Rao, P. T., *Ind. J. Phys.*, 1962, **36**, 85.
4. Patel, M. M. and Abraham, K. C., *Ind. J. Pure & Appl. Phys.*, 1969, **7**, 641.
5. Sivaji, Ch. and Rao, P. T., *Curr. Sci.*, 1969, **38**, 432.
6. Patel, M. M. and Abraham, K. C., *Proc. Phys. Soc. (J. Phys. B)*, 1970, **3**, 1183.

STABILITY OF A HETEROGENEOUS CONDUCTING FLUID WITH THE COMBINED EFFECT OF CORIOLIS AND RADIAL GRAVITATIONAL FORCE

N. RUDRAIAH AND S. NARASIMHA MURTHY

Post-Graduate Department of Mathematics, Visvesvaraya College of Engineering, Bangalore-1

ONE interesting application of magnetohydrodynamic stability theory is in the study of oscillations in the atmosphere in the presence of solar magnetic field. In particular, considerable interest is attached to the flow of a fluid with a vertical gradient of density in meteorological problems. Recent space science research investigations show that there is a considerable effect of earth's or the solar magnetic field on a stratified conducting fluid in the atmosphere. Still more important, there is the coriolis force to be considered. The stability of such fluids, is, therefore, of importance in meteorological problems. Recently, Rudraiah (1970) has investigated the stability of heterogeneous incompressible, non-viscous perfectly conducting fluid between fixed coaxial cylinders with an applied magnetic field in the azimuthal direction and a radial gravitational force. The present purpose of this article is to examine the combined effect of coriolis and radial gravitational forces with magnetic field on the stability of such a system.

We consider the flow of a heterogeneous incompressible inviscid and perfectly conducting fluid between two co-axial cylinders of radii a and b, and with the flow and the magnetic field in the azimuthal direction. The stability equation, against axisymmetric disturbances of the type exp i $(\alpha z - \beta t)$ (where β is a complex quantity and α is a real positive number) and linearizing the basic equations is

$$D\left(\frac{\rho_0}{r} D r u_r\right) + \frac{1}{C^2} \chi(r)\, u_r - \alpha^2 \rho_0 u_r = 0, \quad (1)$$

where

ρ_0 is the density, u_r is the radial velocity

$$C = \frac{\beta}{\alpha}, \quad D = \frac{d}{dr}$$

$$\chi(r) = \left\{\frac{1}{r^3} D(\rho_0 V_0^2 r^2) - SrD\left(\frac{H_0}{r}\right)^2 - \left(\frac{V_0^2}{r} + G\right) D\rho_0 - 2\,TrCD\left(\frac{\rho_0}{r}\right)\right\}$$

$$S = \frac{\mu H_0^2}{\rho_0 U^2}, \text{ cowling number}$$

$$G = \frac{g}{\rho U^2},$$

$$T = \frac{\Omega}{a U},$$

Ω angular velocity

$$C = C_r + iC_i,$$

The boundary conditions are

$$u_r = 0 \text{ at } r = a, \quad r = b \quad (2)$$

From the general definition of stability theory, we know that if C is real, the motion is stable and if C is complex, the motion is unstable. We find the nature of C from the stability equation (1) by using the boundary conditions (2). For this, we multiply the equation (1) by $r\bar{u}_r$ where $\bar{u}_r$ is the complex conjugate of $\bar{u}_r$, integrating between a and b and using the boundary condition (2) and equating the imaginary part of the resulting equation to zero, we obtain

$$\frac{2C_i}{(C_r^2 + C_i^2)} \int_a^b \{K_1 + (C_r^2 + C_i^2) K_2\}\, r\, |u_r|^2\, dr = 0, \quad (3)$$

where

$$K_1 = \frac{1}{r^3} D(\rho_0 V_0^2 r^2) - SrD\left(\frac{H_0}{r}\right)^2 - \left(\frac{V_0^2}{r} + G\right) D\rho_0$$

$$K_2 = T\rho_0\left(\beta + \frac{1}{r}\right),$$

$$\beta = -\frac{1}{\rho_0} D\rho_0.$$

Hence, if k_2 does not change its sign in (a, b) and if

$$T > \frac{K_1}{\rho_0\left(\beta + \frac{1}{r}\right)}, \quad (4)$$

then the motion is stable. We notice that the factor $\rho_0(\beta + 1/r)$ does not change its sign in (4), thus whether the motion is stable or unstable will depend on the sign of K_1.

(*i*) If K_1 does not change the sign, the integrand will never be zero, and hence $C = 0$. This means that the motion is stable.

(*ii*) Even if K_1 changes its sign, but if the magnitude of the coriolis force is such that (4) is satisfied, the motion is stable.

If, the coriolis force, magnetic field and gravitational forces are absent, then as can be seen from (3), the motion will be stable if $\rho_0/r^3 D(V_0^2 r^2)$ does not change its sign in (a, b).

Thus we can conclude that the combined effect of magnetic field and coriolis force is to add to the stability of the system.

ACKNOWLEDGEMENTS

One of us (S. N. M.) is grateful to C.S.I.R. for providing financial assistance.

---

1. Rudraiah, N., *Publ. Astro. Soc., Japan*, 1970, **22**, **41**.

LETTERS TO THE EDITOR

CRYSTAL DATA OF SOME MONONUCLEOTIDES

Disodium Salts of Adenosine (5′) Triphosphate Trihydrate, Uridine (3′) Phosphate Tetrahydrate and Cytidine (5′) Phosphate

As part of a stereochemical analysis of the constituents of nucleic acids we have studied the space group and cell dimensions of the nucleotides: disodium salts of Adenosine (5′) Triphosphate Trihydrate [ATP (5′) $Na_2.3H_2O$], Uridine (3′) Phosphate Tetrahydrate [UMP (3′) $Na_2.4H_2O$] and of Cytidine (5′) Phosphate [CMP (5′) Na_2]. They were crystallized by slow diffusion of acetone into water solutions of the respective samples. The space groups were determined from Weissenberg and Precession photographs taken with CuK_α radiation. The densities were measured by the flotation method using mixtures of acetone and bromoform and also of carbon tetrachloride and bromoform. A summary of the crystal data is given in Table I.

TABLE I

Crystal data

		ATP (5′) $Na_2.3H_2O$	UMP (3′) Na_2 $4H_2O$	CMP (5′) N
Formula	..	$C_{10}H_{14}N_5O_{13}P_3.Na_2.3H_2O$	$C_9H_{11}N_2O_9P.Na_2.4H_2O$	$C_9H_{12}N_3O_8P.Na_2.X$
M.W.	..	619·1	440·2	367·2
System	..	Orthorhombic	Orthorhombic	Orthorhombic
a	..	31·62±0·1 Å	6·476±0·002 Å	48·25±0·15 Å
b	..	21·13±0·05 Å	39·653±0·012 Å	20·87±0·07 Å
c	..	7·13±0·03 Å	6·483±0·002 Å	9·14±0·02 Å
V	..	4765·28 $Å^3$	1734·26 $Å^3$	9203·7 $Å^3$
Z	..	8	4	24 (?)
$d_{meas.}$	..	1·797 gm. cm^{-3}	1·689 gm. cm^{-3}	1·622 gm. cm^{-3}
$d_{calc.}$	..	1·726 gm. cm^{-3}	1·686 gm. cm^{-3}	1·581 gm. cm^{-3}
$\mu(CuK_\alpha)$	..	36·9 cm^{-1}	27·7 cm^{-1}	25·2 cm^{-1}
Systematic	..	*h*00 *h*-odd	*h*00 *h*-odd	*h*00 *h*-odd
Absences	..	0*k*0 *k*-odd	0*k*0 *k*-odd	0*k*0 *k*-odd
				001 ?
Space group	..	$P2_12_12$	$P2_12_12$	$P2_12_12$ ($P2_12_12_1$)

ATP (5′) Na_2 grows as very thin, long and flaky crystals from water-acetone mixtures. If grown from water-dioxane mixtures they were predominantly needle-like. Some of the dried crystals were quite stable to X-rays and gave data extending to the limit of the copper sphere of reflection. These crystals have the space group $P2_12_12$, unlike the ATP (5′) Na_2 crystals ($P2_12_12_1$) whose structure was recently solved by Kennard *et al.* (1970). UMP (3′) Na_2 were obtained as fine needles from uridine 2′ (3′) monophosphoric acid (mixed isomers).
of CMP (5′) Na_2 grow both as long
very thin films. The crystals give b
in wet condition.

We thank Prof. P. S. Narayanan for
interest in this work.

Dept. of Physics, B. SWAMINATH
Indian Institute of M. A. VISWAM
Science,
Bangalore-12, India, *May* 17, 1971.

1. Kennard, O., Isaacs, N. W , Coppola, J. C
A. J., Warren, S., Motherwell, W. D. S.,
D. G., Wampler D. L., Chenery, D. H.,
A. C., Ann Kerr, K. and Riva Di Sansev
Nature, 1970, **225**, 333.

STUDIES ON NUCLEIC ACID GALLOCYANIN REACTION

IN studies on suspended matter in sea,[1] th
was felt for an analytical method for dete
nucleic acid along with phosphorus and
in microgram amounts of material. Th
bilities were investigated of adapting Ei
histochemical method[2] involving the
gallocyanin as a specific stain for nucleic

In the first set of experiments, 1
nucleic acid (pro analysi) was dissolved
ml water containing 4 drops of ammoni
solution of gallocyanin (GC 1) was prep
heating 0·15 g gallocyanin (Bayer, Sta
into solution in a 5% aqueous solution of c
alum. The solution was filtered and gall
reagent solution (GC 2) was prepared by

ing the filtrate tenfold with 1 : 1 (v/v) sulphuric acid. 1 ml volumes of GC 2 solution were added to 0·4–2·0 ml volumes of nucleic acid solution. The reaction mixtures were made to final volumes of 10 ml with 1 : 1 (v/v) sulphuric acid. After 30 minutes' reaction time the optical density was measured in Zeiss Elkophotometer Elko II (420 mµ filter ; 3 cm cell). Fresh reagent solutions were used throughout (*cf.* Sandritter *et al.*[3] regarding influence of age and method of preparation of reagent on the reaction). Typical results are given in Fig. 1. The optical density for 100 mg nucleic acid is 0·001.

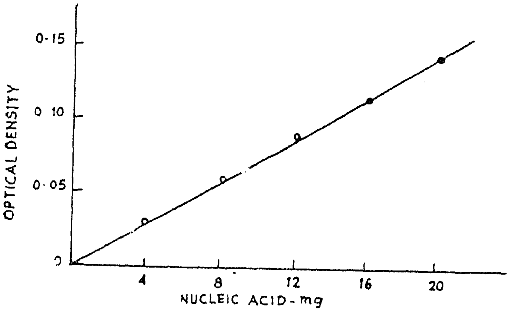


FIG. 1. Optical density of nucleic acid-gallocyanin complex (Reagent GC 2).

The sensitivity of the reaction could be increased tenfold by modifying the experimental conditions as follows : Gallocyanin reagent solution (GC 3) was prepared by diluting 1 ml GC 1 solution with 20 ml 40% (v/v) aqueous methanol. GC 3 solution was used between 24 and 48 hours of its preparation. 0·4–2·0 ml of 0·01% aqueous solution of nucleic acid was made to 2 ml volume and treated with 7 ml of 0·02 N HCl (pH = 1·70) and 1 ml of GC 3. The optical density was measured after 2 hours' reaction time. Results are given in Fig. 2. The optical density for 100 µg nucleic acid is 0·01 which is identical with value obtained by Sandritter *et al.*[4] who used the more elaborate procedure of precipitating the nucleic acid-gallocyanin complex and dissolving the precipitate in urea before measuring the optical density.

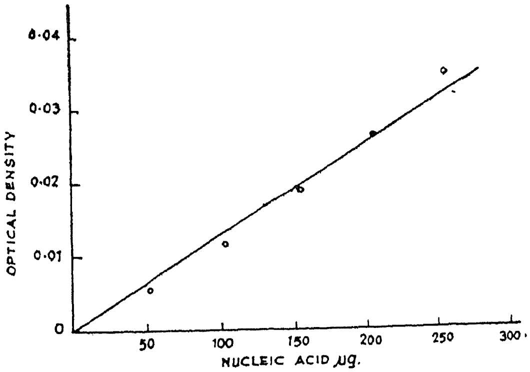


FIG. 2. Optical density of nucleic acid-gallocyanin complex (Reagent GC 3).

The present data indicate the scope of the nucleic acid-gallocyanin colorimetric reaction in environmental surveys of the type recently reported.[5,6]

The author is grateful to Prof. J. Krey under whose guidance the work was carried out at the Institute für Meereskunde, Universität Kiel. His thanks are also due to Dr. A. K. Ganguly, Head, Health Physics Division, Bhabha Atomic Research Centre, Bombay, for his interest in the work.

Health Physics Division, R. VISWANATHAN.
Bhabha Atomic Research Centre,
Bombay-85, *March* 6, 1971.

1. Viswanathan, R., *Kieler Meeresf.*, 1960, **16**, 48.
2. Einarson, L., *Acta Pathol. Microbiol. Scandinavica*, 1951, **28**, 82.
3. Sandritter, W., Kiefer, G. and Rick, W., *Introduction to Quantitative Cytochemistry*, Academic Press, New York, 1966, p. 295.
4. —, Diefenbach, H. and Krantz, F., *Experientia*, 1954, **10**, 210.
5. Holm-Hansen, O., *Limnol. Oceanogr.*, 1969, **14**, 740.
6. Pillai, T. N. V. and Ganguly, A. K., *Curr. Sci.*, 1970, **39**, 501.

PHASE STUDIES IN THE SYSTEM $Fe_xCa_{(1-x)}Nb_2O_6$

THE structures of columbite and fersmite have been studied[1-3] but the present system is a new study. In order to study the phases developed during the substitution of Fe^{2+} by Ca^{2+}, and to investigate the structural relation of fersmite ($CaNb_2O_6$) with columbite ($FeNb_2O_6$), we synthesised the columbite, fersmite and the intermediate compositions (Table I) and made an X-ray study.

The samples were prepared by mixing appropriate proportions of the component oxides followed by standard ceramic techniques. All the samples were fired at 1100° C for twenty hours and at 1350° C for five hours in air and quenched to room temperature. The X-ray patterns of these samples were taken by using a 14 cm diameter Debye-Scherrer camera with Fe Kα radiation. The patterns thus obtained were used for the phase studies and determination of lattice parameters. The results are given in Table I.

TABLE I

The system : $Fe_x\ Ca_{(1-x)}Nb_2\ O_6$

Sr. No.	Composition	Molecular weight	Colour	Density	Phases present
A	$Fe_{0.8}Ca_{0.2}Nb_2O_6$	334·82	Light grey	4·55	Columbite + Fersmite $a = 5·714$, $b = 15·05$, $c = 5·019$ Å
B	$Fe_{0.6}Ca_{0.4}Nb_2O_6$	3 1·64	,,	4·60	Columbite + Fersmite $a = 5·737$, $b = 15·05$, $c = 5·058$ Å
C	$Fe_{0.4}Ca_{0.6}Nb_2O_6$	328·46	Grey	4·62	Fersmite $a = 5·751$, $b = 15·05$, $c = 5·09$ Å
D	$Fe_{0.2}Ca_{0.8}Nb_2O_6$	325·28	,,	4·65	Fersmite $a = 5·760$, $b = 15·05$, $c = 5·109$ Å
E	$Ca\ Nb_2O_6$	322·10	Light brown	4·78	Fersmite $a = 5·764$, $b = 15·05$, $c = 5·169$ Å

It is observed from Table I. that the synthetic fersmite is isostructural with the naturally occurring mineral, with a single phase. The lattice parameters of the synthetic and naturally occurring minerals are

	Lattice dimensions in Å			Author
	a	*b*	*c*	
Fersmite mineral	5·764	15·09	5·232	Hess and Trunipour[3]
Synthetic ..	5·764	15·05	5·169	Present study

It is expected that on introduction of a bigger ion Ca^{2+} ($r = 0·99$ Å) substituting Fe^{2+} ($r = 0·74$ Å), the lattice should expand. It is observed that the lattice increases along a_0 and c_0 axes, whereas along b_0 axis it remains constant. Even on introduction of 20% of Ca^{2+} the fersmite phase appeared, but the lines of fersmite were very faint. On further substitution the lines due to fersmite were predominant. On introducing 60% Ca^{2+} the columbite phase completely vanished and only one phase of fersmite appeared. From this it can be inferred that the columbite and fersmite are isostructural, *i.e.*, the MO_6 polyhedra are linked together in chains along a_0 axis and the neighbouring octahedra share edges.

Dept. of Structural and Inorganic Chemistry,	V. V. DESHPANDE.*
Institute of Science,	V. S. DARSHANE.
Nagpur,	K. RAMA RAO.
February 24, 1971.	

---

* Dept. of Chemistry, Rajaram College, Kolhapur.

1. Tavora, *Anais Acad. Brasileira Ciene*, 1955, **27**, 18.
2. Rama Rao, K. and Deshpande, V. V., *Chem. Comm.*, 1968 **22**, 1418.
3. Hess, H. D. and Trunipour, H. J., *Am. Min.*, 1959, **44**, 1.

ELECTRIC DIPOLE MOMENTS OF SOME LESS STUDIED ALIPHATIC AMINES

ELECTRIC dipole moments for normal as well as isopentylamines have not been reported earlier[1] except for the first members, *i.e.*, *n*-pentylamine[2,3] and isopentylamine.[2] The solution moments of alkylamines, in general, are found to be higher than their theoretically calculated or gaseous moments. Presence of association through hydrogen bonding and a positive solvent effect have been suggested as the main factors governing this increase. In the present paper the observed electric dipole moments of isopentylamine, diisopentylamine and triisopentylamine in benzene have been analyzed in the same light. The moments for the last two amines are entirely new to the literature.

Halverstadt and Kumler's standard equation[4] for polarization at infinite dilution ($P_{2\infty}$) was employed for evaluation of the electric dipole moments from the static dielectric constant and the specific volume data of amines in benzene solution. The detailed techniques have been described elsewhere.[5,6] The variations of the dielectric constants and the specific volumes were found to be linear with concentration of solute (ranging from 0·009 to 0·01 by weight fraction). The constants, α, β, ϵ_1 and v_1 appearing in Halverstadt-Kumler's equation, were evaluated by the method of least squares.[7] Benzene (S. Merck, G.R.), isopentylamine, diisopentylamine and triisopentylamine (all from BDH, England) were further purified by distillation in a quickfit apparatus under suitable conditions and the fractions boiling at 79·5° C, 95–96° C, 187–188° C and 234° C respectively were collected for use. The measurements were made at 30° C. The results are summarized in Table I.

TABLE I

Electric dipole moments for amines in benzene

Compound	α^a	β^a	$P_{2\infty}$	(P_e+P_a)	μ^a obsd.
Isopentylamine	2·35	0·22	74·36	28·71	1·51 1·53^b
Diisopentylamine	1·17	0·16	96·06	52·14	1·48
Triisopentylamine	0·28	0·15	100·20	75·57	1·11

Note: (*a*) The uncertainty in the determination of α, β, the constants appearing in Halverstadt-Kumler's equation and μ is ± 0·01 in each. (*b*) Ref. 2.

Ammonia molecule is a flattened pyramid with nitrogen atom at the top. The molecule has a three-fold axis of symmetry; the resultant dipole vector lies on this axis and makes an angle of 68° with H-N bond.[8] Amines are formed by the replacement of one or more hydrogen atoms in ammonia by alkyl groups. The inclusion of an alkyl group in ammonia molecule should tend to decrease the overall moment of the molecule due to the fact that moment vector $\vec{\mu}$(R-N), 0·62 D, contributes lesser than the moment vector $\vec{\mu}$ (H-N), 1·30 D; R representing an alkyl group.[9] This is observed when we compare the gas moment of ammonia with those of amines. The calculated moments for alkylamine and dialkylamine from the geometry of the molecules assuming $\vec{\mu}$(R-N), $\vec{\mu}$(H-N) and $\vec{\mu}$(C-N) to be equal to 0·62 D, 1·30 D and 0·22 D respectively, and all the bond angles to be 110°, come out to be 1·27 D and 1·08 D respectively. These values agree well only with the gaseous moments of methylamine (1·28 D) and dimethylamine (1·02 D). The moments calculated by Onsagar's equation in case of ammonia, methylamine and dimethylamine in liquid state, have been found to be abnormally high suggesting the formation of associated complex through hydrogen bonding. The solution moments in benzene also differ very much in the magnitude probably due to such an association of the molecules. Krishna and Srivastava[3] found *n*-pentylamine possessing a comparatively high moment of 1·62 D in benzene, which has been attributed to the same effect. The solution moments of these amines are also governed by a positive solvent-effect as suggested by Higasi[10] and observed in number of cases in this laboratory.[6,11,12]

The electric dipole moments of isopentylamine in the present report (Table I) are found to be higher than the calculated or gaseous values available for some of the first members of the homologous series. This may partly be due to the presence of positive solvent-effect. The greater difference of moments in case of isopentylamine and diisopentylamine is in accordance with the expectation of their tendency of associated complex formation through hydrogen bonding. The present observed moment for isopentylamine (1·51 D) is in good agreement with that reported by Rao[2] in benzene at 30° C (1·53 D). The gas moments for all the three compounds or solution moments for diisopentylamine and triisopentylamine are not available in the literature for comparison. However, a perusal of the results in Table I indicates that the electric dipole moment of diisopentylamine is slightly high.

The authors are thankful to the C.S.I.R. (New Delhi) for the financial assistance in the progress of this work.

Dept. of Chemistry, University of Allahabad, Allahabad.
BAL KRISHNA.
AHMAD MASOOD.
BHARTENDU PRAKASH.*

March 13, 1971.

---

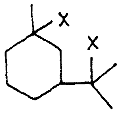
* To whom all correspondence is to be addressed at Department of Chemistry, Indian Institute of Technology, Kanpur-16, India.

1. McClellan, A. L., *Tables of Experimental Dipole Moments*, W. H. Freeman & Co., London, 1961.
2. Rao, D. V. G. L. N., *Ind. J. Phys.*, 1959, **33**, 51.
3. Krishna, B. and Srivastava, A. N., *J. Chem. Phys.*, 1962, **37**, 1574.
4. Halverstadt, I. F. and Kumler, W. D., *J. Am. Chem. Soc.*, 1942, **64**, 2988.
5. Prakash B., *D Phil. Thesis*, University of Allahabad, 1968.
6. Krishna, B. and Srivastava, A. N., *Aust. J. Chem.*, 1966, **19**, 1847.
7. Mellor, J. W., *Higher Mathematics for Students of Chemistry and Physics*, Dover, 1954, p. 326.
8. Herzberg, G., *Infrared and Raman Spectra of Polyatomic Molecules*, Van Nostrand, New York, 1945, p. 439.
9. Smyth, C. P., *Dielectric Behavior and Structure*, McGraw-Hill, 1955, p. 311.
10. Higasi, K., *Bull. Inst. Phys. Chem. Res. Japan*, 1935, **14**, 146; *Pap. Inst. Phys. Chem. Res.*, Tokyo, 1936, **28**, 284.
11. Krishna, B. and Prakash, B., *Aust. J. Chem.*, 1969, **22**, 2679.
12. —, Moghe, C K. and Prakash, B., *J Chem, Soc. A*, 1970, p. 3367.

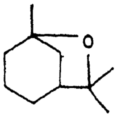
(±)-SYLVETERPIN AND *m*-CINEOLE

As a prologue to our study on the stereochemistry of sylveterpins, we required pure samples of (±)-sylveterpins (I, X = OH) and *m*-cineole (II).

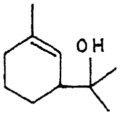
Two optically inactive sylveterpins, m.p. 94° and 127° designated respectively as *cis*- and *trans*-carveterpin are known.[1-3] Of these, the lower melting modification was prepared by sulphuric acid catalysed hydration of dihydrocarvestrenol (III),[1,2] and the other form, from *trans*-carvestrene dihydrobromide (I, X = Br) by treatment with silver acetate and subsequent hydrolysis of the diacetate by alcoholic potash.[1,3]



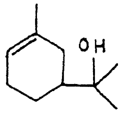
I



II



III



IV

Concerning *m*-cineole, Perkin and Tattersall[4] noted its formation during the reaction between methyl magnesium iodide and ethyl cyclohexanone-3-carboxylate. The incomplete study of the action of 15% aq. oxalic acid on sylveterpineol, *viz.*, a mixture of *m*-menthenols (III) and (IV) by Haworth, Perkin and Wallach[5] apparently suggested the feasibility of exploiting this raw material for securing *m*-cineole. Kuczynski[6] obtained the oxide by refluxing (+)-*cis*-sylveterpin, m.p. 75° [pure sample melts at 84° (unpublished result)] with 5% aq. oxalic acid.

On the whole, there is no guarantee to the homogeneity of the sylveterpins and *m*-cineole referred to in literature.

Stirring of (±)-sylvestrene dihydrochloride (I, X = Cl) (17 g) with 2% aq. sodium hydroxide (850 ml) at 70–75° during 5 hr afforded crude carveterpins (14·3%, m.p. 75°) which by the use of *tlc* [Kiesel-G-plate; ethyl acetate/*n*-hexane/*n*-butanol (1 : 2 : 1); detection by vanillin in conc. sulphuric acid] showed the presence of two components. Upon repeated fractional precipitation from benzene/petroleum ether (40–60°), the mixture was resolved into pure *tlc* (as above) terpins; *cis* 0·25%, R_f 0·76; *trans* 2·4%, R_f 0·66; their melting points coincided with literature values.[1-3] The preparation of the terpins from (±)-sylvestrene dihydrochloride is novel.

When sylveterpineol[7] (50 g), b.p. 90–92°/5 mm, $(\alpha)_D^{25} + 46 \cdot 70°$ ($CHCl_3$, c 1·0), n_D^{30} 1·4782 was refluxed for 5 hr with 15% aq. oxalic acid (500 ml), dehydration occurred and pure [*glc* (column SE–30, temp. 125°), single peak; *tlc* as above in benzene/acetone (8 : 2), single spot; R_f 0·86] *m*-cineole was obtained (5·4%). The structure of *m*-cineole as (II) is established for the first time by spectral data. I.r. (neat) spectrum disclosed bands at 2915 and 2955 cm^{-1} ($\geqslant$C–H), 1455 cm^{-1} ($>C<^{H}_{H}$), 1355 and 1365 cm^{-1} [$>$ $C(CH_3)_2$], 1075 and 1140 cm^{-1} ($\geqslant$ C–O–C $\leqslant$) and 890 cm^{-1} r(CH_2 ring) and n.m.r. (60 MHz. CCl_4) spectrum showed signals at τ 8·7 (*s*, 3H, CH_3), 8·8 and 8·85 (*s*, 6H, gem-dimethyl), and 7·6–8·5 (complex *m*, 9H, 4 × CH_2, CH).

Satisfactory elemental analyses were obtained for the compounds reported here.

In the above discussion we have retained the *cis-trans* configuration of the sylveterpins as in literature.

Department of Chemistry, P. M. ABRAHAM.
Christian Medical College, J. VERGHESE.
Vellore-2, *February* 17, 1971.

---

1. Perkin, W. H. and Tattersall, G., *J. Chem. Soc.*, 1907, **91**, 480.
2. Fisher, K. and Perkin, W. H., *Ibid.*, 1908, **93**, 1889.
3. Baeyer, A., *Chem. Ber.*, 1894, **27**, 3490.
4. Perkin, W. H. and Tattersall, G., *J. Chem. Soc.*, 1907, **91**, 503.
5. Haworth, W. N., Perkin, W. H. and Wallach, O., *Ibid.*, 1913, **103**, 1237.
6. Kuczynski, H., *Roczinki Chemii*, 1952, **26**, 152.
7. Kaimal, K. G. and Verghese, J., *Curr. Sci.*, 1969, **38**, 191.

OXIDATION OF FLUOREN-9-OLS BY Cr (VI)

THE oxidation of a number of secondary alcohols by Cr(VI) has been studied in recent times.[1] Conflicting views on the mechanism of these reactions have been expressed especially regarding the nature of the loss of the secondary hydrogen.[2] We have now chosen an interesting series of substrates, namely, fluoren-9-ol and its substituted derivatives. In continuation of our earlier work,[3] we are now investigating thoroughly the kinetics of these reactions. The kinetics of the oxidation of fluorene by Cr(VI) have been reported to be complicated,[4] However, the oxidation of fluoren-9-ols are clean exhibiting a total order of two (Fig. 1) being first with respect to each one of the reactants (Table I).

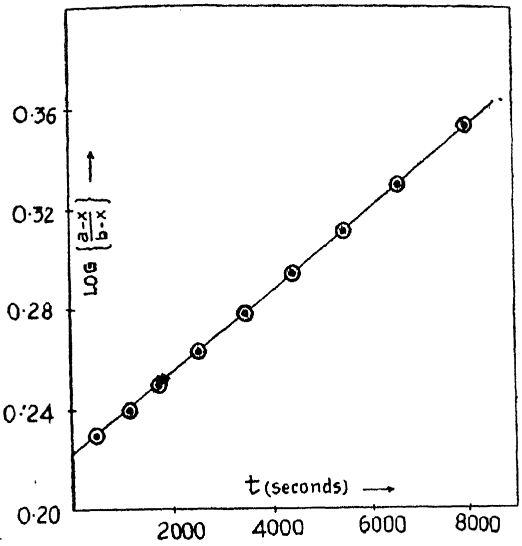


FIG. 1. [Fluoren-9-ol] = 0·005 M; $[CrO_3]$ = 0·003002 M; $\mu = 0\cdot2$; Solvent; 80% HOAc-20% H_2O (v/v); Temp.: 55° C.

TABLE I

Solvent: 80% HOAc-20% H_2O (v/v); $\mu = 0\cdot2$
Temp. 55° C

[Fluoren-9-ol]	$[CrO_3]$	$k_1 \times 10^4$ sec^{-1}	$^*k_2 \times 10^2$
0·00500 M	0·003002 M	..	1·89
0·01012	0·002100	1·88	1·85
0·01212	0·002100	2·28	1·88
0·01439	0·002100	2·75	1·91
0·01648	0·002100	3·19	1·94
0·01868	0·002100	3·47	1·86
0·02089	0·002100	4·02	1·92
0·02310	0·002100	4·44	1·92
0·02500	0·002100	4·88	1·95
0·02500	0·003017	4·68	1·87
0·02500	0·004121	4·57	1·83
0·02500	0·005020	4·63	1·85
0·02500	0·006005	4·64	1·86

* Litre $mole^{-1}$ sec^{-1}.

The investigations were made in binary solvent mixtures of acetic acid and water under conditions of constant ionic strength.

A comparison of the rates of oxidation of the 2-substituted fluoren-9-ols (Table II) reveals that electron withdrawing substituents retard the rate.

TABLE II

Solvent: 80% HOAc-20% H_2O (v/v); $\mu = 0\cdot2$
Temp. 55° C

Substituent	$k_2 \times 10^3$ lit. $mole^{-1}$ sec^{-1}
-H	18·9
$-NO_2$	5·3
$-NH_2$	26·0
-Cl	9·67
-Br	9·45
-I	9·91
-CN	6·86

A plot of log k against σ_{meta} yields a ρ value of $-0\cdot786$ (correlation coefficient $= 0\cdot9670$) (σ_m values were employed since substituents at the 2 position are meta related to the reaction centre). This probably indicates the formation of an electron-deficient carbon centre in the rate-limiting step due to the cleavage of the C-H bond.[2] Small negative ρ values of this order have been obtained in the Cr(VI) oxidations of *p*-substituted α-phenyl ethanols ($\rho = -1\cdot01$),[5] *para*-substituted toluenes ($\rho = -1\cdot2$),[6] diaryl carbinols ($\rho = -0\cdot54$),[7] and *para*-substituted mandelic acids ($\rho = -1\cdot51$).[8]

The definite rate benefit with increasing concentration of acetic acid in the medium [*e.g.*, k_2 (litre $mole^{-1}$ sec^{-1}) values at 55° C in 70–30, 80–20 and 90–10 acetic acid-water mixtures are $9\cdot44 \times 10^{-3}$, $18\cdot9 \times 10^{-3}$ and $39\cdot3 \times 10^{-3}$ respectively] is in conformity with the observations on other systems. The energy of activation for the oxidation of fluoren-9-ol by Cr(VI) in 80–20 (% v/v) acetic acid-water mixture is 13·73 k cals per mole and the entropy is $-24\cdot8$ e.u.

Department of Chemistry, Vivekananda College, Madras-4, *February* 24, 1971.
V. M. SADAGOPA RAMANUJAM.
N. VENKATASUBRAMANIAN.

---

1. Wiberg, K. B., *Oxidation in Organic Chemistry*, Academic Press, New York, London, 1965.
2. Venkatasubramanian, N., *J. Sci. Ind. Res.*, 1961, **20 B**, 385.
3. —, *Proc. Ind. Acad. Sci.*, 1961, **53**, 80.
4. Ogata, Y. and Akimoto, H., *J. Org. Chem.*, 1962, **27**, 294.
5. Kwart, H. and Francis, P. S., *J. Amer. Chem. Soc.*, 1955, **77**, 4907.
6. Ogata, Y., Fukui, F. and Yuguchi, S., *Ibid.*, 1952, **74**, 2707.
7. Ross Stewart and Fariza Banoo, *Can. J. Chem.*, 1969, **47**, No. 17.
8. Venkatasubramanian, N. and Sundaram, S., *Ind. J. Chem.*, 1970, **8**, 1104.

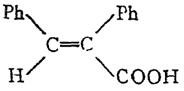
A STEREOSPECIFIC CLAISEN/STOBBE CONDENSATION

ABSTRACT

The alkoxide catalysed reaction of methyl phenylacetate and aromatic aldehydes gives quantitatively a mixture of *cis* α-carbomethoxystilbene and *cis* α-carboxystilbene simultaneously. The configuration of the acid has been established; and it has been shown that it is not a hydrolytic product of the ester. The simultaneous formation of the products is explained as being formed through the stabler erythro diastereomer of the initially formed oxyanion, which undergoes elimination to give the Claisen product, and forms a *β*-lactone which cleaves to the Stobbe product.

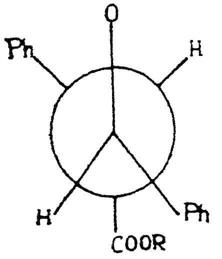
THE Claisen condensation of methyl phenyl acetate with aromatic aldehydes gives α-carbomethoxystilbene.[1] It is found that the alkoxide catalysed reaction of methylphenylacetate and aromatic aldehyde gives a mixture of *cis* α-carbomethoxystilbene and *cis* α-carboxystilbene in quantitative yields, *e.g.*, with benzaldehyde in potassium tert. butoxide at room temperature α-carbomethoxystilbene (60%) and *cis* α-carboxystilbene (I) (40%) are obtained.

The configuration of the acid has been established by its U.V.[2,3] $\lambda_{\text{max.}}^{\text{EtOH}}$ 220 mμ (log ε 4·28), 278 mμ (log ε 4·21) and its m.p. 172° (and m.m.p 172-3°) with an authentic sample of *cis*-α-carboxystilbene prepared by the method of Buckles and Hausman.[3]

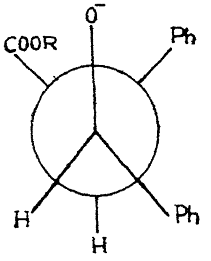


1

It is unlikely that the acid is formed as a hydrolytic product of the ester, because the ester when kept under identical experimental conditions could be recovered quantitatively. Further, the rates of saponification of the ester under conditions approaching experimental conditions, as well as, reported in the literature[1] are extremely low.



IIa



IIb

The simultaneous formation of the products can be explained as follows. The initial condensation of the phenyl acetate anion with the carbonyl of the aldehydes will lead to the oxyanion. The stabler *erythro* form[5] (II *a*) of the oxyanion through its suitable conformer (II *b*) for *trans* β-elimination will lead to the Claisen product α-carbomethoxystilbene; the conformer (II *b*) is also sterically particularly suitable to form a β-lactone which on cleavage will lead to *cis* α -carboxystilbene in a Stobbe type of mechanism.

The details will be published elsewhere. One of us (B. H. P.) is grateful for a CSIR Fellowship.

Department of Chemistry, B. H. PATWARDHAN.
Nagpur University, G. BAGAVANT.
Nagpur, *May* 17, 1971.

---

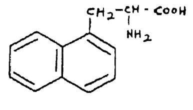
1. de Schuttenbach, Y., *Ann. Chim.*, 1936, **6**, 53.
2. Coddington, J. F. and Mosettig, E., *J. Org. Chem.*, 1952 **17**, 1027.
3. Fieser, L. F., *Experiments in Organic Chemistry*, D C. Heath and Co., Boston, 1955, p. 152.
4. Buckles, R. E. and Hausmann, *J. Amer. Chem. Soc.*, 1948, **70**, 45.
5. Gould, E. S., *Mechanism and Structure in Organic Chemistry*, Henry Holt and Co., N.Y., 1959, p. 192.

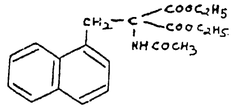
SYNTHESIS OF β-1-NAPHTHYLALANINE AND β-(9-PHENANTHRYL)-ALANINE

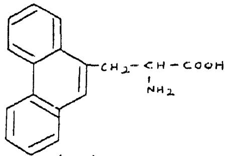
WE required large quantities of β-1-naphthylalanine (I) and β-(9-phenanthryl)-alanine (II) for the synthesis of naphthoindolizidine and phenanthroindolizidine derivatives as antileukamia agents.[1] They have been now prepared in good yields by making use of the acetamidomalonic ester synthesis.

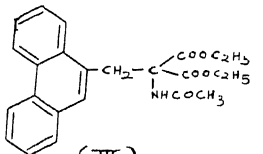
Diethylacetamidomalonate (4·74 g) was refluxed with sodium ethoxide obtained from sodium (0·5 g) and absolute ethanol (40 ml) for 2 hours. 1-Chloromethylnaphthalene (4 g) was then added and the whole reaction mixture refluxed for 4 hours on sand bath. It was then cooled and the solvent evaporated at reduced pressure. The thick syrupy liquid was then diluted with water and kept overnight in freeze. The separated diester (III) was filtered, purified by chromatographing over alumina using chloroform as eluent and finally crystallised from benzene-petroleum ether mixture in colourless crystals, M.P. 108°. Yield 6·5 g, Carbonyl absorption in IR region 1750 cm^{-1} (ester $> C = O$ group) and 1685 cm^{-1} (Amido $> C = O$ group).

The above diester (III) (5 g) was refluxed with hydrobromic acid (48% ; 30 ml) for 8 hours. Hydrobromide separated on cooling and crystallised from water, m.p. 263° (decomp.). Free amino-acid was precipitated by treating the above hydrobromide with ammonia. β-1-Naphthylalanine[2] crystallised from water. M.P. 240°. Yield 2·8 g.


(I)


(III)


(II)


(IV)

Similar condensation of 9-chloromethylphenanthrene with diethyl sodio acetamido malonate gave the diester (IV). It crystallised from benzene-petroleum ether mixture. M.P. 142°. Yield 40%. This diester (IV) on hydrolysis with 48% hydrobromic acid followed by treatment with ammonia afforded β-(9-phenanthryl) alanine. M.P. 210°.

All compounds described above gave satisfactory analytical results.

Thanks are due to Professor E. Gellert, Wollongong University College, Wollongong, Australia, for the IR Spectra, Professor S. Sethna for his interest in the work and Dr. S. S. Lele for microanalysis of the samples.

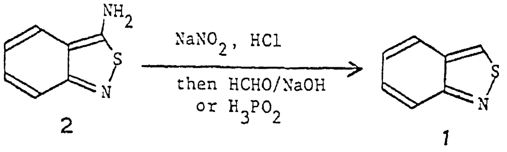
Chemistry Department, D. O. Shah.
Faculty of Science, K. N. Trivedi.
M.S. University of Baroda,
Baroda-2, *March* 2, 1971.

---

1. Gellert, E. and Rudzats, R., *J. mednl. Chem.*, 1964, **7**, 361.
2. Dittmer, K., Herz, W. and Cristol, S. J., *J. Biochem.*, 1948, **173**, 323.

A NOVEL SYNTHESIS OF 2, 1-BENZISOTHIAZOLE (THIOANTHRANIL)

Only three methods of preparation of 2, 1-benzisothiazole (thioanthranil) (1) have so far been described in the chemical literature. The first two involve the reduction of o-nitrotoluene-α-thiol[1] or the oxidation of o-aminotoluene-α-thiol;[2] the third and most recent method utilises the reaction between o-toluidine and thionyl chloride in boiling xylene solution.[3]



We now wish to report a fourth synthesis. 3-Amino-2, 1-benzisothiazole (2), which is readily prepared[4] by a two-step reaction from the commercially available o-aminobenzonitrile,[5] is diazotised with hydrochloric acid and sodium nitrite. Treatment of the resulting diazonium chloride solution with alkaline formaldehyde solution, or with hypophosphorous acid, affords thioanthranil in moderate yield.

Since a considerable number of substituted 3-amino-2, 1-benzisothiazoles is known,[4,6,7] and since certain 2, 1-benzisothiazoles possess potent biological activity, especially gastric antisecretory activity,[4,8] this reductive deamination procedure may prove of some value in preparing not only thioanthranil itself but also substituted thioanthranils not readily accessible by the earlier methods.

Experimental

3-Amino-2, 1-benzisothiazole (2)[4] (1·0 g) was dissolved in warm hydrochloric acid (1·3 M ; 32 ml). This solution was cooled in an ice-bath, when the amine hydrochloride separated. Aqueous sodium nitrite solution (10% ; 4 ml) was added portionwise with shaking; the final mixture was allowed to stand for about 10 minutes to complete diazotisation, and was then added slowly to a stirred mixture of formalin (37% HCHO ; 5 ml), water (13 ml) and sodium hydroxide (2·0 g). The rapid decomposition of the diazonium salt, and consequent evolution of nitrogen, caused some frothing during this addition. The mixture was then steam-distilled, and the distillate extracted with diethyl ether. Evaporation of the dried extract afforded thioanthranil (2, 1-benzisothiazole) (1) (0·35 g, 40%), which was identified by comparison of its n.m.r. and infrared spectra with those of an authentic sample, and by observation of the m.p. of the picrate derivative. The latter m.p. and mixed m.p. was 123–125° (lit.[9] 123–124°).

Hypophosphorous acid was equally effective as the alkaline formaldehyde in the second step of this procedure.

Dept. of Chemistry,
La Trobe University,
Bundoora, Victoria 3083,
Australia, *March* 9, 1971.

MICHAEL DAVIS.
K. S. L. SRIVASTAVA.

---

1. Gabriel, S. and Stelzner, R., *Chem. Ber.*, 1896, **29**, 160.
2. Goerdeler, J. and Kandler, J., *Ibid.*, 1959; **92**, 1676.
3. Davis, M. and White, A. W., *Chem. Commun*, 1968, p. **1547**.
4. Meyer, R. F., Cummings, B. L, Bass, P. and Collier, H. O. J., *J. Med. Chem.*, 1965, **8**, 515.
5. E.g., from the Fluka A. G. Chemische Fabrik, Switzerland.
6. Seefelder, M. and Armbrust, H., (Badische Anilin und Soda-Fabrik A. G.), Belgian Patent 670652; *Chem. Abstr.*, 1967, **66** 65467.
7. Ross, S. T., (Smith Kline and French Company), U.S. Patent 3254094; *Ibid.*, 1966. **65**, 5464.
8. Bass, P., Purdon, R. A. and Patterson, M. A., *J. Pharmacol. Exp. Ther.*, 1966, **153**, 292.
9. Gabriel, S. and Posner, T., *Chem. Ber.*, 1895, **28**, 1025.

2-(2-QUINOLYLAZO)-4-PHENANTHROL AND ITS METAL CHELATES

2-HYDRAZINOQUINOLINE was prepared by the method of Perkin and Robinson[1] and 9, 10-phenanthrenequinone was prepared by the method of Schultz.

2·4 g of 9, 10-phenanthrenequinone was dissolved in one litre of aqueous methanol (80%) and a solution of 2·0 g of 2-hydrazinoquinoline in 50 ml of 6 M HCl was added with constant stirring. The resulting solution was neutralized with ammonia solution when a dark brown precipitate of 2-(2-quinolylazo)-1-phenanthrol (abbreviated as QAP) separated out, the yield being 90%. The product was recrystallised from ethyl alcohol and its melting point was found to be 234-36° C. The purity of the sample was checked by thin layer chromatography in which only one spot was obtained. Analysis of the compound corresponded with the molecular formula $C_{23}H_{15}N_3O$.

QAP is a dark brown solid. It is insoluble in water, dilute acids and alkalies. However, it is soluble in acids ($pH < 2$) to give a cation, yellow in colour which is due to the protonation of the nitrogen in the quinoline ring. In strong alkalies ($pH > 10$) it is slightly soluble to give an anion, pink in colour on account of the loss of a proton from the hydroxy group. It is soluble in methyl alcohol, ethyl alcohol, 1, 4-dioxane, carbon tetrachloride, chloroform, isopropyl alcohol and benzene.

In addition to metal ions listed in Table I, QAP has been found to form coloured chelates with Co(II), Ni(II), Ag(I), Au(III), Sb(III), Ca(II), Ba(II), Sr(II), Bi(III), Os(VIII) and U(VI). The colour reactions are particularly sensitive for zinc, cadmium, mercury, copper, nickel, iron, cobalt and palladium.

The pH of the solution is of great importance for the formation of the chelates and minimum pH for chelation varies from metal to metal. All these chelates are insoluble in water. However, some of the chelates are soluble in common organic solvents. The colours of these chelates are recorded in Table I.

TABLE I

Colour of metal chelates of QAP (Solids and in organic solvents)

Metal ion		Solid	CCl_4	$CHCl_3$	C_6H_6	CH_2Cl_2
Zn (II)	..	Red	Red	Red	Red	Red
Cd (II)	..	Violet	,,	,,	,,	,,
Cu (II)	.	Blue	Blue	Blue	Blue	Blue
Fe (II)	..	Red	Red	Red	Red	Red
V (V)	..	Green	Green	Green	Green	Green
Pd (II)	..	,,	,,		,,	,,
Hg (II)	..	Pink	Pink	Pink	Pink	Pink
Pb (II)	..	,,	,,	,,	,,	,,
Mn (II)	..	Red	Red	Red	Red	Red
Nb (V)	..	Yellow	Yellow	Yellow	Yellow	Yellow
Ta (V)	..	,,	,,	,,	,,	,,

One of the authors (R. N. V.) is thankful to the Council of Scientific and Industrial Research (India) for the award of the Junior Research Fellowship.

Dept. of Chemistry,
University of Delhi,
Delhi-7,
March 4, 1971.

R. N. VIRMANI.
B. S. GARG.
R. P. SINGH.

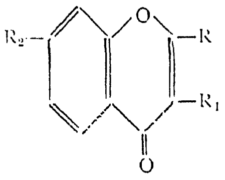
---

1. Perkin, W. H. and Robinson, R., *J. Amer. Chem. Soc.*, 1913, **103**, 1977.
2. Schultz, K. E., *Ber.*, 1885, **18**, 506.

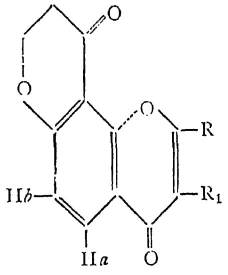
SYNTHESIS OF γ-PYRONOCHROMANONES

In our previous communications[1-4] we have reported that the cyanoethylation of hydroxycoumarin derivatives followed by hydrolysis and cyclisation affords a convenient method for the synthesis of linear and angular α-pyronochromanones. The present communication describes the synthesis of γ-pyronochromanones by the application of cynoethylation on hydroxy chromone, flavone and isoflavone derivatives.

7-Hydroxy-2-methylchromone when reacted with acrylonitrile in the presence of alkali afforded the nitrile I *a*, m.p. 152–54° (Found C, 68·4 ; H, 5·0 ; N, 6·3 Calcd. for $C_{13}H_{11}O_3N$; C, 68·2 ; H, 4·8 ; N, 6·5%) which was hydrolysed to the corresponding propionic acid I *b*, m.p. 169–71° (Found C, 63·1 ; H, 5·1 Calcd. for $C_{13}H_{12}O_5$; C, 62·9 ; H, 4·9%). The latter on cyclisation afforded only one compound (TLC) m.p. 183–85° (Found C, 67·3 ; H, 4·7 Calcd. for $C_{13}H_{10}O_4$; C, 67·8 ; H, 4·3%) which on the basis of the n.m.r. spectrum was assigned the angular structure II *a*. The protons H_a and H_b were identified as doublets (δ $CHCl_3$ 6·95 and 8·25, J = 9 cps). It gave a 2, 4-dinitrophenylhydrazone m.p. 286–88° (Found: N, 14·1 Calcd. for $C_{19}H_{14}N_4O_7$; N, 13·7%).



I



II

	R	R₁	R₂
(*a*)	CH₃	H	O (CH₂)₂ CN
(*b*)	CH₃	H	O (CH₂)₂ CO₂H
(*c*)	Ph	H	O (CH₂)₂ CN
(*d*)	Ph	H	O (CH₂)₂CO₂H
(*e*)	CH₃	Ph	O (CH₂)₂CN
(*f*)	CH₃	Ph	O (CH₂)₂CO₂H

	R	R₁
(*a*)	CH₃	H
(*b*)	Ph	H
(*c*)	CH₃	Ph

Similarly, 7-hydroxyflavone (nitrile I *c*, m.p. 135–37° ; Found C, 74·0 ; H, 4·7 ; N, 4·9 Calcd. for $C_{18}H_{13}O_3N$; C, 74·2 ; H, 4·5 ; N, 4·8%) ; acid I *d*, m.p. 247–49° ; Found C, 69·2 ; H, 4·8 Calcd. for $C_{18}H_{14}O_5$; C, 69·7 ; H, 4·5%) also yielded only the angular chromanone II *b*, m.p. 218–20° (Found C, 74·0 ; H, 4·2 Calcd. for $C_{18}H_{12}O_4$; C, 74·0 ; H, 4·1%) as indicated by its n.m.r. spectrum. The protons H_a and H_b were identified as doublets (δ $CDCl_3$ 6·98 and 8·22, J = 9 cps). It gave a 2, 4-dinitrophenylhydrazone, m.p. 265–67° (Found N, 11·9 Calcd. for $C_{24}H_{16}N_4O_7$; N, 11·9%).

7-Hydroxy-2-methylisoflavone (nitrile I *e*, m.p. 144–46° ; (Found C, 74·1 ; H, 4·9 Calcd. for $C_{19}H_{15}O_3N$; C, 74·6 ; H, 4·9% : acid I *f*, m.p. 182–84° ; Found C, 70·5 ; H, 5·0 Calcd. for $C_{19}H_{16}O_5$ C, 70·4 ; H, 4·9%) also gave only II c, m.p. 184–86° (TLC) (Found C, 74·5 ; H, 5·0 Calcd. for $C_{19}H_{14}O_4$; C, 74·5 ; H, 4·5%) whose structure was confirmed by its n.m.r. spectrum which showed the protons H_a and H_b as doublets (δ $CDCl_3$ 6·93 and 8·28, J = 9 cps). Its 2, 4-dinitrophenylhydrazone melted at 268–70° (Found N, 11·3 Calcd. for $C_{25}H_{19}O_7N_4$; N, 11·5%).

It is interesting to note that whilst 7-hydroxycoumarin derivatives gave both the linear and the angular chromanones, in the case of the chromone and flavones only the angular derivative is obtained.

The cyanoethylation of 5-hydroxy-2-methylchromone and 5-hydroxyflavone failed to occur even under drastic conditions and the original compound was recovered unchanged. This is probably due to the hydrogen-bonding between the hydroxyl and the carbonyl groups which is also reported[5] to inhibit other reactions such as methylation.

Organic Chemistry Research Labs., Institute of Science, Bombay-32, *February* 20, 1971.
J. R. Merchant.
J. R. Patell.
Mrs. S. M. Thakkar.

---

1. Merchant, J. R. and Patell, J. R., *Curr. Sci.*, 1968, **37**, 404.
2. — and —, *J. Chem. Soc.*, 1969 (**C**), 1544.
3. — and —, *Tetrahedron Letters*, 1970, 8, 555.
4. —, — and Mrs. Barve, N. V., *J. Indian Chem. Soc.* (under print).
5. Elderfield, R. C., *Heterocyclic Compounds*, Vol. II, John Wiley & Sons, Inc., 1951, p 265.

EFFECT OF AN INTRAUTERINE CONTRACEPTIVE SUTURE ON THE UREA CONTENT OF UTERINE FLUID OF RATS

It has been reported that an intrauterine contraceptive device (IUCD) causes a marked increase in urea concentration of uterine fluid in women ; the blood urea level, however, continues to be within normal range.[1,2] It has been suggested that because of its well-known protein denaturing action,[3] such excessive quantities of urea in the uterine fluid of IUCD fitted women may be detrimental to the viability of the preimplantation blastocyst.[1,2] The present communication records a similar increase in urea level of the uterine fluid of rats fitted with an IUCD.

Colony-bred albino rats (120–130 g) of the Institute were fitted with a surgical nylon suture in the right uterine horn under asepsis according to the procedure described previously.[4] The contralateral horn served as the sham-operated control. The animals were maintained in air-conditioned (75 ± 2° F) quarters under standardized husbandry conditions throughout the experimental period. The uterine fluid from each horn was aspirated under sterile conditions 300 days after insertion of the device or sham operation. The fluids from 3 uterine horns from a particular side were pooled (total 15 animals) and each sample (0·4–0·5 ml) was centrifuged in cold at 3,000 r.p.m. The clear supernatant was taken for estimation of urea by the procedure of Tarnoky.[5] For comparison, the blood urea level of the same animals was determined.

The urea concentration of the uterine fluid of IUCD horn ($74\cdot17 \pm 0\cdot44$ mg/100 ml) was found to be about 50% higher than that of the control horn ($49\cdot48 \pm 1\cdot19$ mg/100 ml, $P < 0\cdot01$). Nevertheless, the blood urea level ($59\cdot87 \pm 1\cdot76$ mg/100 ml) was within normal range and 25% lower than that of the uterine fluid from IUCD horn ($P < 0\cdot01$).

It is thus apparent that as in women,[1,2] an IUCD causes a marked increase in urea concentration of the uterine fluid in rats without causing any change in its blood level. It has been reported that in this rodent species blastocysts undergo degeneration as they enter the uterine horn bearing an IUCD[5]; the 'delayed implanting' blastocysts also meet with the same fate in the IUCD-fitted horn.[7] It has been opined that the toxicity of the uterine luminal milieu is responsible for such degeneration of the preimplantation blastocysts.[4,6] The present results suggest that the IUCD-induced rise in urea level contributes importantly to the transformation of the uterine fluid into an unphysiological medium for survival of the blastocysts.

This investigation was supported by grants from the Ministry of Health and Family Planning, Government of India, and the Ford Foundation. The authors are grateful to Dr. M. L. Dhar for his interest in this study.

Central Drug Res. Inst.,
Lucknow (Communication
No. 1592),
April 12, 1971.

AMIYA B. KAR.
V. P. KAMBOJ.
S. R. CHOWDHURY.

1. Kar, A. B., Engineer, A. D., Dasgupta, P. R. and Srivastava, A. K., *Am. J. Obst. Gynec.*, 1969, **104**, 607.
2. —, —, Goel, R., Kamboj, V. P., Dasgupta, P. R. and Chowdhury, S. R., *Ibid.*, 1968, **101**, 966.
3. Haurowitz, F., *Chemistry and Biology of Proteins*, Academic Press, Inc., New York, 1950.
4. Kar, A. B., Goswami, A., Kamboj, V. P. and Chowdhury, S R., *Steroids*, 1964, **4**, 159.
5. Tarnoky, A. L., *Clinical Biochemical Methods*, Hilger and Watts, London, 1958.
6. Doyle, L. L. and Margolis, A. L., *Science*, 1963, **139**, 833.
7. Kar, A. B., Kamboj, V. P. and Datta, J. K., *J. Rep. Fertl.*, 1964, **8**, 139.

HAEMAGGLUTINATING ACTIVITY IN NORMAL CULTURE FLUID OF *AEDES ALBOPICTUS* CELL LINES.

ABSTRACT

Normal non-infected culture fluids of *Aedes albopictus* larval cells showed haemagglutinating (HA) activity. Such activity was observed occasionally with the culture fluids of *Aedes aegypti*, but not with *Aedes w-albus* and *Aedes vittatus* cells. The demonstration of HA activity in the extracts of freshly hatched *A. albopictus* larvae as well as in freshly set up primary cultures indicated that this phenomenon in the culture fluids of *A. albopictus* is not due to extraneous viral contamination of the culture but is probably the inherent property of the mosquito cells.

WHILE studying haemagglutinating (HA) and complement fixing (CF) antigens in Singh's *Aedes albopictus* (ATC-15) cell culture infected with different arboviruses, it was noticed that the culture fluid from non-infected *A. albopictus* cells also agglutinated goose erythrocytes. Further characterization of this haemagglutinin was carried out with a view to find out whether this was due to extraneous viral contamination of the culture or due to an inherent property of the cell itself.

Erythrocytes from different species of animals including goose, rooster, human '0' group, guinea-pig and sheep were tested and it was found that only goose, human '0' group and to a certain extent guinea-pig erythrocytes gave agglutination. Optimum pH for agglutination was 6·0. Culture fluids from freshly seeded *A. albopictus* (137th passage) when tested on second or third day showed low HA titres of 1 in 4 or 1 in 8. However, in the older cultures, *i.e.*, 10 to 14 days after seeding, there was an increase in HA titres, reaching 1 in 32 or 1 in 64. The HA titres were not very consistent and varied in different batches of culture fluids. Treatment with protamine sulphate or acetone did not significantly affect the HA, except for an occasional improvement in the pattern. The HA activity was heat labile (56° C for 30 min.). Antisera of Japanese encephalitis, West Nile, dengue types 1, 2, 3, 4, chikungunya and Batai viruses prepared in mice did not inhibit the haemagglutination. Furthermore, the extracellular fluid from normal non-infected cell cultures did not react in CF test with antisera prepared against chikungunya or polyvalent group A sera (obtained from Communicable Disease Centre, Atlanta, U.S.A.).

Differential centrifugation of the normal culture fluids at 6,000 G for one hour, and 105, 400 G for 2 hours showed that the haemagglutinin could be sedimented only at 105,400 G. HA activity was not observed in the intracellular material which was obtained by removing the culture fluid, followed by washing the cell sheet with balanced salt solution and breaking the cells by freezing and thawing with the same quantity of fresh medium. However, low grade activity was detected in the sediment after centrifugation at 105,400 G for 2 hours and at a concentration ten times the original volume. Haemadsorption was observed with goose cells, but the optimum pH for this phenomenon was 6·2 or 6·4.

It was thought that this culture which was at 137th passage level might have been contaminated by some extraneous virus. *A. albopictus* (ATC-15) cell cultures stored in liquid nitrogen at earlier passage levels (14th and 34th passages) were, therefore, revived and tested for HA. It was found that these cultures also contained such HA activity. The other two cell lines of *A. albopictus*, ATC-16 in 71 passage and ATC-18 in 67 passage, maintained in this laboratory, also showed HA activity. Three sets of *A. albopictus* primary cell cultures prepared on different days also developed HA activity by 14 to 21 days after seeding.

Cell cultures prepared from larvae of other two species of mosquitoes, namely, *Aedes w-albus*[1] and *Aedes vittatus*[2] failed to yield haemagglutinin at any time, although occasional HA was present in cell cultures prepared from larvae of *A. aegypti*. The culture fluid of *A. albopictus* showing HA activity was inoculated in *A. w-albus* culture. These inoculated culture fluids of *A. w-albus* were tested subsequently for the presence of HA activity, but were found negative.

Freshly hatched larvae of *A. albopictus* were sonicated thrice, for a period of one minute each with one minute interval with Branson sonifier, model W 185 E. The suspension was centrifuged at 800 G for 15 minutes. The supernatant was found positive for HA activity and the titre was between 1 in 4 to 1 in 16. This activity was unaffected even after treatment with acetone.

The extracellular media or intracellular material of Singh's *A. albopictus* (ATC-15) cell line showing HA activity did not show any sign of sickness or mortality in infant mice when inoculated intracerabrally. However, Banerjee and Singh[3] showed that chikungunya virus after several passages in *A. albopictus* cultures loses its mouse virulance, without affecting its infectivity to Vero cultures. Therefore, the extracellular fluid showing HA activity was tested for cytopathic effect and production of plaques in Vero cultures and found to be negative.

These preliminary studies indicate that the haemagglutinin in normal non-infected *A. albopictus* cell cultures is not due to the presence of any extraneous viral agent but is probably due to some inherent property of the cells or could be due to some latent virus present in the larvae. Further characterisation of this haemagglutinin is in progress.

The authors are grateful to Dr. K. M. Pavri, Deputy Director, Virus Research Centre, Poona, for her keen interest and helpful suggestions.

Virus Research Centre, S. N. Ghosh.
Indian Council of U. K. M. Bhat.
Medical Research,
Poona, India. *February* 24, 1971.

---

1. Singh, K. R. P. and Bhat, U. K. M., *Experientia*, 1971, **27**, 142.
2. Bhat, U. K. M. and Singh, K. R. P., *Curr. Sci.*, 1970, **39**, 388.
3. Banerjee, K. and Singh, K. R. P., *Ind. J. Med. Res.*, 1969, **57**, 1003.

FREE AMINO-ACIDS IN THE TISSUES OF *BELOSTOMA INDICA* LEP. *ET* SERV. (HEMIPTERA: BELOSTOMIDAE)

The amino-acid constituents of the tissues of the carnivorous Hemipteroid insects are not well known. The only tissue which has been analysed to find out amino-acid constituents is the haemolymph of *Rhodnius prolixus*[1,2] and *Belostoma* sp.[3] The amino-acid constituents of the midgut, haemolymph, thoracic muscles and the ovaries of the adults of *Belostoma indica* have been analysed by the author to find out the distribution of free amino-acids in these tissues.

The adults of *Belostoma indica* were collected from places near the street lights on the bank of a nearby river. The insects were washed several times with distilled water and dried with filter-paper. The hindleg of the insect was cut at its base and the clear drops of haemolymph oozing from the wound were collected on strips of filter-paper. After drying, the parts of the strips containing haemolymph were directly placed in 90% ethanol for about 2 hours after which the strips were removed from ethanol and discarded.

The midgut, thoracic muscles and ovaries were dissected out from the anaesthetised insects and the adhering tissues were cleared off. The contents were removed from the midgut. The tissues were then washed twice in distilled water and dried over filter-paper. Each tissue was then crushed on a separate piece of chromatographic paper and the spot so obtained was quickly dried. The part of the paper containing the material was then cut into small pieces which were wrapped in another piece of filter-paper. The packet containing the material was kept in 90% ethanol for about 2 hours after which it was removed from ethanol and discarded.

The ethanolic extract of each tissue was concentrated and directly applied to a sheet of chromatographic paper Whatman No. 1 with the help of a platinum wire. Two-dimensional chromatograms of each tissue were prepared in *n*-butanol, acetic acid and water (4 : 1 : 1) and phenol, water (4 : 1). The amino-acids were located by spraying the paper with 0·2% ninhydrin. The amino-acids of the chromatograms of unknown material were identified by comparing them with the chromatograms of standard known amino-acids which were prepared under similar conditions.

Sixteen amino-acids namely, alanine, arginine, cystine, glutamic acid, glycine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, proline, serine, threonine, tyrosine and valine were detected both in the midgut and haemolymph of *Belostoma indica*. This suggests that these amino-acids have diffused into the haemolymph from the midgut. Pant and Agarwal[3] detected tryptophan in traces in the haemolymph of *Belostoma* sp. studied by them and which is not present in the haemolymph of the species analysed by me ; in addition the present species contains arginine in high concentrations which was not detected by them. These differences in the composition of the haemolymph suggest that the species of *Belostoma* analysed by them was probably different from that analysed by me. Lefroy[4] has recorded two species of *Belostoma* from India.

All the amino-acids of the haemolymph except methionine, phenylalanine and tyrosine are present in the thoracic muscles of *Belostoma indica*. The absence of these three amino-acids and the presence of an unidentified ninhydrin positive compound in the muscles suggest that these changes have occurred during metabolism in this tissue. The metabolism of phenylalanine is well known, it is converted into tyrosine[5,6] and the derivatives of tyrosine are used in cuticle synthesis and melanogenesis.[7,8]

Except methionine and proline all the amino-acids of the haemolymph are present in the ovaries which contain tryptophan in addition. The absence of methionine and proline in the ovaries suggests the incorporation of these amino-acids in the formation of eggs.

My grateful thanks are due to Dr. R. Rakshpal, Professor of Zoology, University of Lucknow, for supervising the work and for constructive criticism.

Research Entomologist, A. P. SAXENA.
U.P. Institute of Agricultural
Sciences,
Kanpur-2, *February* 24, 1971.

---

1. Harington. J. S., *Parasitology*, 1961, **51**, 309.
2. Pickett. C. and Friend, W. G., *Canadian J. Zool.*, 1966, **44**, 241.
3. Pant, R. and Agarwal, H. C., *J. Insect Physiol.*, 1964, **10**, 443.
4. Lefroy, H. M., *Indian Insect Life*, Calcutta and Simla, **1909**.
5. Fukuda, J., *Nature, Lond.*, 1956, **177**, 429.
6. Gilmour, D., *The Biochemistry of Insects*, Academic Press, New York and London, 1961.
7. —, "Metabolism of amino-acids" In *The Metabolism of Insects*, Oliver and Boyd, Edinburgh and London, 1965.
8. Hackman, R. H., *Biochem. J.*, 1953, **54**, 371.

MANGO DECLINE CAUSED BY CATION AND ANION IMBALANCE

ALTHOUGH mango decline is becoming a serious problem in the northern region of our country, there seems to be no attempt made to ascertain its possible causes. The symptoms first appear on the old leaves with the collapsing of leaf tissues in clearly defined marginal areas of brick red colour towards the tip. Later, with increasing severity almost the entire lamina gets affected (Fig. 1). The younger leaves in general remain unaffected upto initial two months of their emergence.

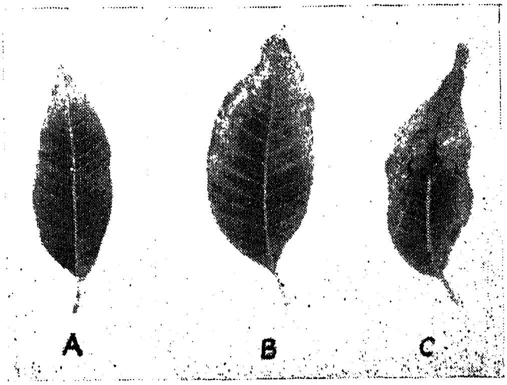


FIG. 1. Leaf burn symptom in mango. A. Tip-burn; B. Affected marginal areas; C. Severity of tip burn.

With a view to ascertaining the causes of this malady in the popular commercial varieties of Chousa and Dashehari, growing in the orchard of Indian Agricultural Research Institute, New Delhi, leaf samples collected from healthy and diseased trees were analysed for the chloride, potassium, calcium and sodium contents on dry weight basis.[1] The amount of chloride in scorched leaves was found to be more than that of the healthy leaves in both the varieties (Table I). In scorched leaves of Chousa it was about four times more whereas in the case of Dashehari it was twice that of control.

TABLE I

Levels of different nutrients in healthy and scorched leaves of mango

(Data expressed as percentage on dry weight basis)

Variety	Condition of leaves	Cl	K_2O	CaO	Na_2O
Chousa	Healthy	0·24	0·68	1·78	0·06
	Scorched	0·87	0·49	2·06	0·10
Dashehari	Healthy	0·09	1·08	1·40	0·09
	Scorched	0·16	0·47	2·54	0·11

The accumulation pattern of calcium and sodium in the healthy and scorched leaves was similar to that of chloride but potassium showed a peculiar trend in both the varieties; the amount of potassium in scorched leaves being less as compared to control in both the cases. However, it was difficult to say whether the scorching was due to the toxicity of chloride ions or due to the effect of cationic imbalance. To arrive at a better understanding of the actual process another experiment was undertaken in which sprays of 2% NaCl, $NaHCO_3$ acd Na_2SO_4 were given to induce artificial scorching of leaves. Analysis of both the healthy and artificially produced scorched leaves, taken from the same tree, for their chloride, potassium, calcium and sodium content, revealed that natural symptoms of scorching of leaves resembled with the artificially induced symptoms by 2% spray of NaCl (Table II).

TABLE II

Levels of different nutrients in healthy and artificially produced scorched leaves of mango var. Dashehari

(Data expressed as percentage on dry weight basis)

Variety	Condition of leaves	Cl	K_2O	CaO	Na_2O
Dashehari ..	Healthy	0·09	0·90	1·82	0·10
	Scorched (2% NaCl spray)	0·25	0·45	1·82	0·47

The amount of chloride in the artificially induced scorched leaves by 2% spray of NaCl increased approximately three times, while the content of potassium was reduced to half as compared to the healthy leaves of the same tree. These observations suggest that potassium deficiency with which the symptoms of this disease resemble is not the cause but a consequence of chloride ion toxicity.

Division of Horticulture
and Fruit Technology,
IARI., New Delhi-12,
February 8, 1971.

R. M. PANDEY.
G. C. SINHA.
P. K. MAJUMDER.
R. N. SINGH.

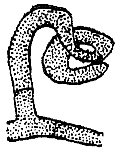
---

1. Homer, D., Chapman and Parker, F., Pratt. *Methods of Analysis for Soils, Plants and Water*, University of California, Division of Agricultural Sciences, 1961.

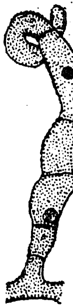
SEXUAL REPRODUCTION IN TWO SPECIES OF *CHAETOMIUM*

SEXUAL reproduction has been studied in *Chaetomium brasiliense*,[1] *C. elatum*,[2] *C. globosum*,[3,4] *C. spirale*,[5] and *C. trigonosporum*.[6]

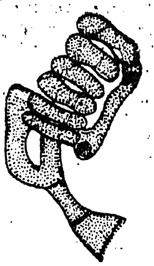
Cytomorphology of sex organs in *C. bostrychodes* and *C. succineum* is reported in this communication. These were cultured on PDA. The mycelium with sex organs, at various stages of development, and proto-perithecia were fixed in Carnoy's fluid for 18-20 hr, transferred to 70% ethanol, and stained with



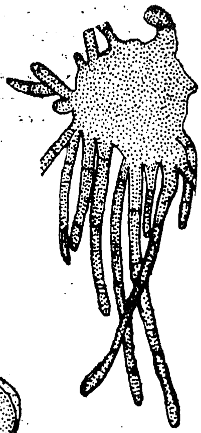
1



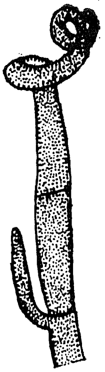
2



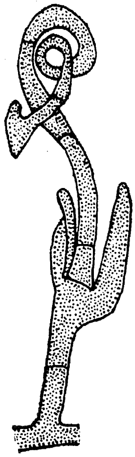
3



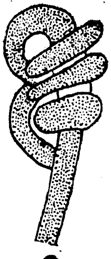
4



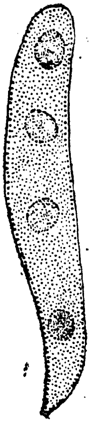
7



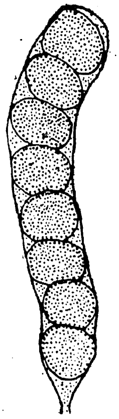
8



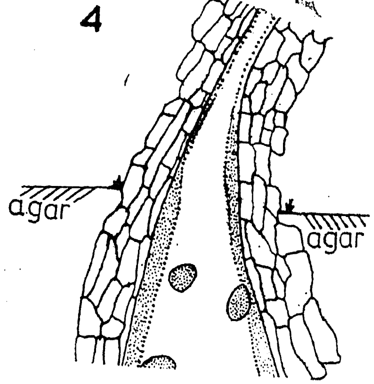
9



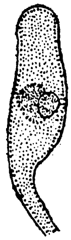
11



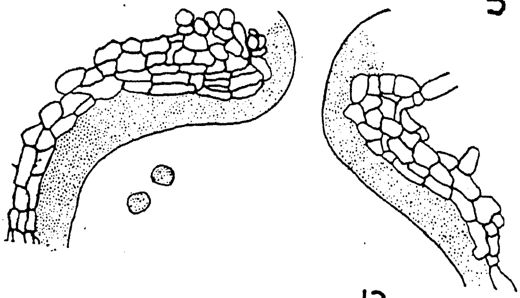
12



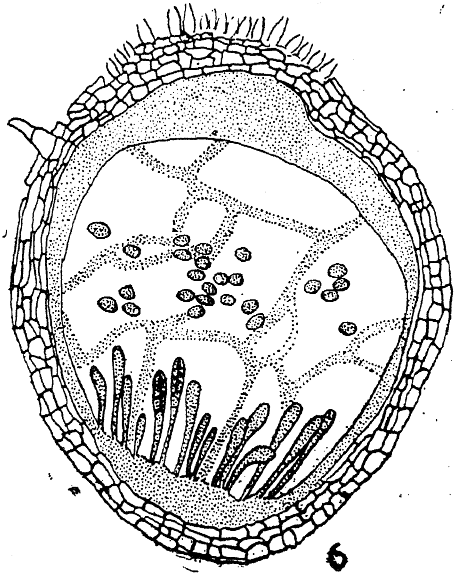
5



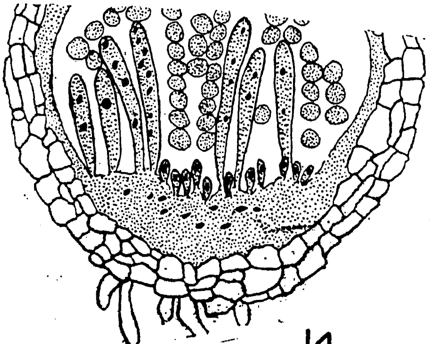
10



13



6



14

FIGS. 1–14. **Figs. 1–6.** *Chaetomium bostrychodes* Zopf. **Figs. 1–3.** Stages in the development of ascogonium, × 400. **Fig. 4.** Protoperithecium, × 400. **Fig. 5.** L.s. submerged perithecium showing portion of neck projecting beyond the agar surface, × 215. **Fig. 6.** L.s. normal perithecium showing paraphyses traversing the central cavity, and well-developed ascogenous system at the base of perithecium, × 180. **Figs. 7–14.** *Chaetomium succineum* Ames. **Figs. 7–9.** Stages in the development of ascogonium, × 380. **Figs. 10–12.** Stages in the development of ascus; 1-nucleate, (**Fig. 10**), 4-nucleate (**Fig. 11**), and mature ascus with 8 ascospores (**Fig. 12**), × 480. **Fig. 13.** L.s. mature, dehisced perithecium showing ostiole, and a large central cavity, × 215. **Fig. 14.** L.s. perithecium showing a well-developed ascogenous system (note the uninucleate young asci, binucleate ascogenous cells, and 1, 2, 4, and 8-nucleate asci), × 215.

propionocarmine. The serial sections (5-8 μ) of mature perithecia were stained with haematoxylin.

The developmental morphology is similar in *C. bostrychodes* and *C. succineum*. The ascogonium (Fig. 1) arises laterally and while the terminal portion gets spirally coiled, the stalk remains erect (Figs. 2, 7). Meanwhile, accessory branches arise from the stalk of the ascogonium (Figs. 3, 8, 9), enclose the terminal coil, and their continued growth contributes to a pseudoparenchymatous sheath (Fig. 4). The young perithecium (Figs. 6, 14) comprises a few ascogenous cells enclosed by a 4- to 6-layered wall; the outer two layers form the carbonaceous zone. Uniseriate hairs develop from the outermost layer of perithecial wall. The expansion of the perithecial cavity is accompanied by the formation of the ascogenous system. While the ascogenous cells are multinucleate, the hyphae are binucleate. The two nuclei of the ascus primordium fuse followed by meiosis and mitosis resulting in eight nuclei (Figs. 10–12). These are arranged linearly in the elongated ascus in *C. succineum*, but irregularly in the club-shaped ascus in *C. bostrychodes* (Figs. 6, 12). The cells of the inner layers of perithecial wall break down and are represented by a cytoplasmic mass (Fig. 13). The spores escape through the ostiole in *C. succineum*, while in *C. bostrychodes* they escape not only through the ostiole but also by the separation of ostiolar ring along with the terminal hairs from the main body of perithecium. Submerged perithecia lacking normal organization have been noticed in *C. bostrychodes* (Fig. 5).

Gries[3] reported a functional antheridium, and an ascogonium which later differentiates into ascogenous hypha in *C. bostrychodes* and *C. globosum*. Such structures have not been reported by later workers[1,4,6,7] nor did I observe them. The ascogenous cells are reported to be uninucleate in *C. trigonosporum*[6] and *C. globosum*[1,2] and multinucleate[8] in *C. succineum* and *C. bostrychodes*.

The author is grateful to Dr. K. G. Mukerji for guidance.

Dept. of Botany, University of Delhi, Delhi-7, *March* 3, 1971. V. RANGA RAO.

---

1. Whiteside, W. C., *Mycologia*, 1957, **49**, 420.
2. van Der Weyen, A., *La Cellule*, 1954, **56**, 211 (cited in Corlett, 1966).
3. Gries, H., *Jahrb. Wiss. Bot.*, 1941, **90**, 233 (cited in Corlett, 1966).
4. Whiteside, W. C., *Mycologia*, 1957, **53**, 512.
5. Dangeard, P. A., *Le Botaniste*, 1907, **10**, 329 (cited in Corlett, 1966).
6. Corlett, M., *Can. J. Bot.*, 1966, **44**, 155.
7. Moreau, F. and Moreau, M. M. E., *Rev. Mycol.*, 1953, **18**, 165.
8. Ranga Rao, V. and Mukerji, K. G., *Preslia*, 1968, **40**, 304.

CARPOPHORE-INDUCING FACTOR FROM SEEDLINGS OF *VALLISNERIA SPIRALIS*

THE *in vitro* formation of normal fruiting bodies in basidiomycetes is one of the most challenging aspects of fungal morphogenesis. Various nutrient media have been devised in recent years for the artificial culture of basidiomycetes. There are, however, very few reports of the induction of fruiting bodies by diffusible substances originating either from the same fungus or from other micro-organisms.[1-3] Leonard and Dick[3] were able to isolate and partially characterise a substance (FIS) from *Hormodendrum cladosporioides*, capable of inducing fruiting bodies in *Schizophyllum commune*.

During my studies on the germination of seeds of *Vallisneria spiralis*, I observed numerous fruiting bodies of *Coprinus lagopus* associated with the seedlings growing in a petri plate containing sterilized moist sand (Fig. 1, A, B). It was of interest to find out whether the association was specific or accidental. Experiments were done to ascertain: (*a*) whether there is a particular substance secreted by the roots of the seedlings that diffuses into the sand and promotes the formation of carpophores, (*b*) whether the *in vitro* grown plants (axenic cultures of *Vallisneria*) also release a substance which promotes fruiting, (*c*) if the mycelia or the spores of *Coprinus* contain a factor which can initiate fruiting in the same fungus, and (*d*) if the substance could be characterised chemically.

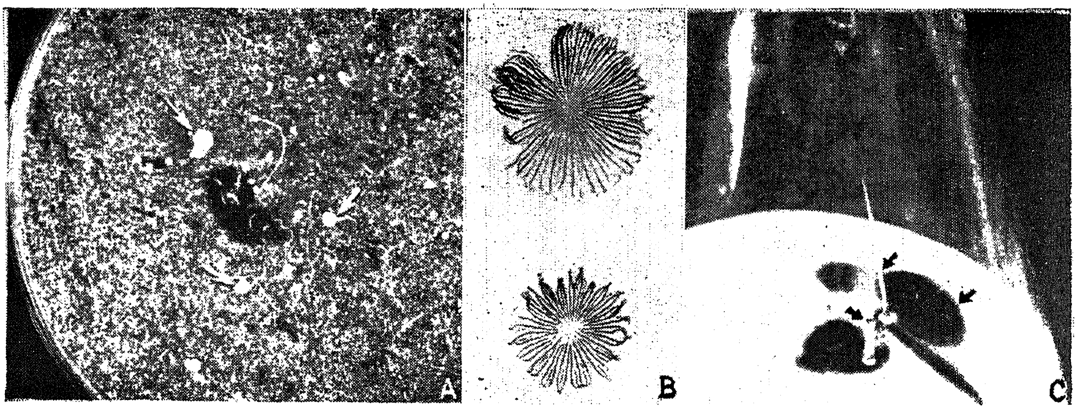


FIG. 1, A–C. (A) Petri plate showing fruiting initials of *Coprinus*, which are white (arrow-marked), amidst *Vallisneria* seedlings (masked by the colour of the sand). (B) Spore prints of *Coprinus* on the inner surface of petri plate cover. (C) Fruiting bodies on agar medium containing *in vitro* extract. Note that the stipe of one of the fully developed fruiting bodies has broken (arrow). The black patches on the medium (arrow) indicate the areas covered by discharged spores.

Seedlings grown in sterile sand were carefully removed and the sand was washed repeatedly with sterile distilled water. The leachate was collected and filtered through Whatman No. 1 filter-paper. The clear solution thus obtained is being referred to in this communication as the *in vivo* diffusate. As a control sterilised sand in which no seeds were planted was washed and filtered. Seedlings were also grown in White's liquid medium. The medium from which the seedlings were removed after 20 days served as the *in vitro* diffusate. White's basal medium in which no plants were grown served as the control. The spore and mycelium were gently separated from the sand and washed in the same manner and the diffusate collected and filtered as before. Ten ml of the diffusate, whether from *in vivo*, *in vitro*, or from the washings of the culture of the fungus, were added to the simple agar medium and autoclaved at 15 lb p.s.i. for 20 minutes. The controls were also treated in the same manner. Pure cultures of *Coprinus* were inoculated in these media. The cultures were kept in continuous light during day and total darkness during night at 25 ± 2° C. Six flasks (250 ml capacity) were used for each treatment.

Fruiting initials appeared seven days after inoculation on the medium containing the *in vivo* diffusate and attained a length of 0·5 cm in 10 days. Differentiation of the fruiting bodies required another four or five days. The carpophores were discharged with such force that the gill portion invariably got stuck to the surface of the flask and a black mass of spores was scattered on the medium (Fig. 1, C). In the controls, vegetative growth was very poor and there were one or two raised areas which did not differentiate further even after 20 days. Whereas five fruiting bodies were formed in each flask containing the *in vivo* diffusate, only one was formed when the *in vitro* diffusate was used. No fruiting bodies were formed in control flasks or in those containing extracts of spores and mycelium of *Coprinus*.

Concentrated *in vivo, in vitro* diffusates and their controls were subjected to thin layer chromatography (TLC) to find out if there were any significant differences among them. No identifiable sugars or amino-acids were detected in the in vivo and control diffusates. However, some unidentifiable spots were seen on the chromatogram of the *in vivo* diffusate. The *in vitro* diffusate and the controls showed no spots other than sucrose which was present in White's basal medium.

That the diffusate from the seedling roots of *Vallisneria* contains a substance capable of inducing fruiting bodies in *Coprinus* is evident from the above experiments. There were 50 seedlings growing in a petri plate containing sand, whereas only one or two seedlings were growing in each test tube containing White's basal medium. The difference in the number of fruiting bodies developing on media supplemented with *in vivo* diffusate and *in vitro* diffusate is probably because of the concentration of the factor. The potentiality of water extracts to induce fruiting even after autoclaving at 15 lb p.s.i., for 20 minutes, suggests that the substance is water-soluble and heat-stable.

I am grateful to Professor B. M. Johri for facilities and encouragement, and to Dr. K. G. Mukerji and Mr. V. Ranga Rao for their valuable help in carrying out the investigation.

Dept. of Botany, M. C. UMA.
University of Delhi,
Delhi-7, *March* 3, 1971.

---

1. Eger, G., *Arch. Microbiol.*, 1965, **50**, 343.
2. Gruen, H. E., *Plant Physiol.*, 1963, **38**, 652.
3. Leonard, T. J. and Dick, S., *Proc. Nat. Acad. Sci.*, USA, 1968, **59**, 745.

REVIEWS AND NOTICES OF BOOKS

Laser Interaction and Related Plasma Phenomena. Edited by H. J. Schwarz and H. Hora. (Plenum Publishing Corporation, New York, N.Y. 10011), 1971. Pp. xiv + 509. Price $ 25.00.

The words of the acronym may not be remembered but one knows that *Laser* is a new scientific device that produces the most powerful beam of monochromatic light. A laser beam directed to the moon and reflected back from it has been observed. The latest practical application of laser is its use in lighthouse to show greater penetration through rain and fog.

The potentiality of high-power lasers to produce extremely high temperatures in interaction with plasma has been shown by recent researches and with advances in laser technology and the use of magnetic methods of containing plasma, energy production by controlled nuclear fusion may be a distant possibility. Low-power lasers as intense monochromatic sources have revived interest in Raman Spectroscopy for the study of the structure of complicated molecules. The use of laser in medicine, photography, interferometry, holography, etc., is coming into prominence. Developments in laser physics and laser applications have been rapid and dynamic and there is a need for a publication which will introduce the subject and review the latest researches in the various fields of study that have been opened up by this new technology. The present book does just that.

It contains the Proceedings of the First Workshop of Laser Interaction and Related Plasma Phenomena, held at Rensselaer Polytechnic Institute, Hartford Graduate Centre, Connecticut, in June 9-13, 1969. The Proceedings comprise review talks presented and discussed at the Workshop by a group of international scientists drawn from universities and development laboratories and actively connected with research and technology in this field.

The material in the book is divided into five sections dealing with historical information on laser interaction and plasma phenomena, principles of interaction of low laser radiation, experimental and theoretical work on laser produced plasmas, and thermonuclear fusion.

A. S. G.

Theory and Practice of Infrared Spectroscopy (Second Edition). By N. L. Alpert, W. E. Keiser and H. A. Szymanski. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xiv + 380. Price $ 18.50.

This is a thorough and uptodate text-book on infrared spectroscopy which presents in a lucid manner the basic concepts of IR, the necessary theory, instrumentation and practical use of this technique in research and industry. The first edition of the book by two of the authors (H. A. S.) and (N. L. A.) appeared in 1964 and was well received. In the present second edition, in the production of which a third author has co-operated, the text has been revised to reflect the current developments in this subject and new additions of importance have been made.

After an introductory chapter, the second and third chapters are devoted to instruments and accessories in which a type of widely used infrared spectrophotometer is described and its operational efficiency and dependance on variable parameters are discussed. The two major chapters in the book are the fourth (pp. 77-183) and the fifth (pp. 184-302), the former providing the fundamental theoretical background to the subject, while the latter is concerned with the use of group frequencies for structural analysis. These are followed by short chapters on quantitative analysis, sample handling techniques, and spectra and reference library.

The text contains a number of IR spectrum charts and about 40 enlarged charts, that could not be accommodated in the page size, are kept in a pocket on the inside of the back cover.

The second edition is sure to have as good a reception as the first by all those who use infrared spectroscopy in research—especially chemists doing structural work—and in routine control work in industrial development.

A. S. G.

International Tables of Selected Constants (Vol. 17). *Spectroscopic Data Relative to Diatomic Molecules.* Director: B. Rosen. (Pergamon Press, Ltd., Headington Hill Hall, Oxford), 1970. Pp. 515. Price not given.

The first edition of these Tables giving collected information about the electronic spectrum and spectroscopic properties of diatomic molecules was published in 1951. A work of this kind rapidly becomes out of date, and more so now because of the fact that the last 20 years has seen large increase in the number of diatomic molecules for which spectroscopic data are available, and moreover, the extent and precision of the data have increased. New techniques like high temperature micro-wave spectroscopy and mass-spectrometric studies of high temperature equilibria have furnished new data not known before.

In the present edition, therefore, the Tables have been completely recast and it is, in fact, an independent and new work brought out by the collaborative effort of more than 30 spectroscopists. It gives a nearly complete survey of the literature on the properties of diatomic molecules up to the end of 1967, and includes the more important work published in 1968 and 1969 also. The publishers proposed to keep the information up-to-date by issuing annually critical abstracts which will contain all the numerical information of the kind which is given in the present volume.

This new edition, together with the proposed Abstract Service, will be indispensable reference sources to all spectroscopic laboratories.

A. S. G.

ANNOUNCEMENTS

The Indian College of Allergy and Applied Immunology

The Fifth Convention of I.C.A.I. will be held from 28th to 30th October, 1971, under the auspices of the Department of Allergy and Applied Immunology, S.M.S. Medical College and Hospital, Jaipur. In addition to the scientific presentation of the papers in the field of Allergy, Applied Immunology and related subjects, there will be a Symposium on Bronchial Asthma. A scientific exhibition will also be held at that time.

Those desirous of presenting papers should communicate to the Chairman, Scientific Committee, and send the abstract not exceeding 300 words before 30th July and full text of the paper not later than 30th August 1971.

Award of Research Degrees

Andhra University has awarded the Ph.D. degree in Mathematics to Shri V. V. Rama Rao; Ph.D. degree in Nuclear Physics to Shri M. L. Narasimha Raju; D.Sc. degree in Geology to Shri K. Kameswara Rao.

Karnatak University, Dharwar, has awarded the Ph.D. degree in Chemistry to Shri S. N. Betkerur.

Osmania University, Hyderabad, has awarded the Ph.D. degree in Botany to Kumari Prathibha Chakrapani.

Utkal University, Bhubaneswar-4, has awarded the Ph.D. degree in Chemistry to Shri B. C. Dash.

ERRATUM

Curr. Sci., June 20, 1971, p. 319, column 1, para 1, line 15, *for* (propylene) *read* (butylene).

Books Received

Morphology. (First Edition.) By P. B. Vaidya. (Dastane Ramachandra and Co., 456, Ravivar Peth, Poona-2), 1970. Pp. vii + 138. Price Rs. 5·50.

Far-Infrared Properties of Solids. Edited by S. S. Mitra and S. Nudelman. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xv + 287.

Equations of State for Solids at High Pressure and Temperature. By V. N. Zharkov and V. A. Kalinin. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011). Pp. x + 257.

2878-71. Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.

ON C–N, C=O AND C=S BONDS IN AMIDES AND THIOAMIDES

K. VENKATA RAMIAH
Department of Physics, Osmania University Post-Graduate Centre, Warangal-1 (A.P.)
AND
V. VENKATA CHALAPATHI
Department of Physics, Sri Venkateswara University Post-Graduate Centre, Ananthapur (A.P.)

In amide molecules, no single valence bond structure is consistent with all their properties. Two possible structures contribute to the resonance hybrid with the dipolar resonance structure making substantial contribution to the ground state of these molecules giving partial single and double characters to the C=O and the C–N bonds. The bond lengths of the C=O and the C–N bonds of several amides have been determined by X-ray diffraction and microwave spectroscopic methods.[1–5] Using this bond length data, Morris and Orville-Thomas[6] have calculated the bond orders of the C=O and the C–N bonds of the amides taking into consideration (*i*) the presence of delocalised π-bonding, and (*ii*) the ionic character of the bond. The values of the bond lengths and the bond orders of the C=O and C–N bonds thus obtained are given in Table I.

TABLE I

Amide	Bond length in Å		Bond order	
	γ (C=O)	γ (C–N)	N (C=O)	N (C–N)
Formamide (solid)	1·255	1·30	1·61	1·71
Formamide (vapour)	1·193	1·376	1·69	1·63
Oxamide (solid) ..	1·25	1·31	1·63	1·69
Succinamide (solid)	1·243	1·315	1·64	1·68

Suzuki[7,8] and Venkata Chalapathi and Venkata Ramiah[9] have carried out the normal coordinate treatment of primary, secondary and tertiary amides. The force constants proposed by these workers for the C=O and C–N stretching vibrations are of the order of 8·8 to 9·0 md/Å and 6·15 to 6·8 md/Å respectively. It is thus obvious that the bond lengths, bond order and the stretching force constants of the C=O and C–N bonds in amides have intermediate values of those of the idealised C=O and C–N bonds.

Venkata Chalapathi and Venkata Ramiah[10] measured the integrated intensities of the carbonyl band in a number of amides and Barrow[11] measured the intensities of the same band in aldehydes, ketones and esters. These values are given in Table II.

TABLE II

Compound		Carbonyl band	
		Frequency (in cm^{-1})	Intensity (moles^{-1} litre-cm^{-2} × 10^4) in solution of CCl$_4$
N methylacetamide	..	1691	3·5
Dimethylacetamide	..	1657	5·2
N-methylpropionamide	..	1688	3·6
Dimethylpropionamide	..	1667	4·4
Propionaldehyde	..	1738	1·55
Benzaldehyde	..	1710	2·10
Acetone	..	1709	1·55
Acetophenone	..	1692	2·1
Methylacetate	..	1751	2·2

The observations in Table II indicate that the integrated intensities of the carbonyl band in amides are much higher than those of the same band in aldehydes, ketones and esters. The intensities of the N–H stretching absorption bands of N-methylamides and N-methylthioamides as measured by Usha Bai and Venkata Ramiah[12] are given in Table III.

TABLE III

Amide		N–H stretching absorption band	
		Frequency (in cm^{-1})	Intensity (moles^{-1} litre-cm^{-2} × 10^4) in solution of CCl$_4$
N-methylacetamide	..	3470	0·52
N-methylpropionamide	..	3467	0·55
N-methylthioacetamide	..	3408	0·73
N-methylthiopropionamide		3407	0·73

The intensities of the N–H stretching absorption bands of the amides given in Table III are much higher than the intensity values of the same bands in amines[13] which are of the order of 0·20 to 0·28 intensity units.

Apart from the description of the amides as the resonance hybrids between O=C–N and $\overset{-}{O}$–C=$\overset{+}{N}$ groups, Cannon[14,15] discussed this problem in terms of interaction and mixing of the π-orbitals of the C=O group and 2 P orbitals of the nitrogen atom in the SP^2 hybrid configuration. Cannon explains that this π–P orbital mixing lengthens the bond length of the C=O bond and shortens that of the C–N bond relative to the valence bond structure and is responsible for the high polarity of the C=O group. The above experimental results can thus be accounted for on the basis of the assumption of electron delocalisation in amides. This imparts considerable double bond character to the C–N bond resulting in a restricted internal rotation about the same bond. A consequence of this fact is that the proton resonance signals of the methyl groups of the tertiary amides occur at different fields at room temperature. A vibrational frequency, recorded in the region of 350 cm^{-1} in the Raman spectra of tertiary amides, is in fact assigned to the torsional mode of the C–N bond.[9]

Examples of rotation about partial double bonds are provided by amides and a number of papers describing the application of NMR methods for the measurement of rotational barriers of tertiary amides have appeared in recent years. The experimental activation energy E_a identified with the barrier height restricting internal rotation about the central C–N bond of the amides, is obtained from the measurements of the rate of internal rotation $1/2\tau$ at a series of temperatures and fitting the data to the Arrhenius equation. The barrier heights, obtained by Rogers,[16] Loewenstein *et al.*[17] and Newman *et al.*[18] for a number of dimethylamides and dimethylthioamides are given in Table IV.

TABLE IV

Amide	Solvent	Activation energy E_a in Kcal/mole
NNDMF	Pure	18·3±0·7
NNDMTF	,,	27·9±1·1
NNDMF	Formamide	26·3±2·6
NNDMA	,,	24·7±0·8
NNDMTA	,,	43·7±5·6

The internal rotation of NNDMF has been reinvestigated by the NMR total line shape (TLS) treatment in recent years[19] taking into account both the variance of non-exchanging N-methyl doublet chemical shift and the coupling between the formyl and N-methyl-protons. The activation energy E_a obtained in these studies in 20·5 ± 0·2 Kcal/mole which is in broad agreement with that obtained by Rogers.

Loewenstein *et al.*[16] obtained the activation energy in case of dimethylthioformamide by measuring the intensity ratio of the peaks since the coalescence temperature in case of this amide is very high. In case of dimethylacetamide and dimethylthioacetamide, Newman *et al.* used formamide as a solvent because of its non-interfering protons and the fact that it would dissolve the thioamides easily. From the observations in Table IV, it is obvious that the height of the barrier in thioamides is much higher than that in the case of the corresponding amides. The higher values for the rotational barriers of the tertiary amides with formamide as a solvent are due to the solvent interaction which is the hydrogen-bonding of the type C=O....H–N or C=S....H–N.

An almost similar result is obtained from the studies of infrared spectra of the amides in pure and vapour states. In vapour state, the intermolecular associations in primary and secondary amides break down with the result that the double bond character of the C–N bond diminishes. Experimental evidence to this effect comes from the reduction in the value of C–N stretching frequency in vapour state[20,21] as shown in Table V.

TABLE V

Amide	C–N stretching frequency of	
	Pure amide	Amide in vapour state
Formamide	1309	1253
N-methylformamide	1248	1201
N-methylacetamide	1300	1257

This result is further substantiated by the fact that the bond length of the C–N bond increases and the bond order of the same bond diminishes from pure amide to vapour state as indicated by values in Table I.

The vibrational frequencies assigned by various workers to the C–N stretching vibration in primary, secondary and tertiary amides and thioamides[7–9,22–24] on the basis of the normal co-ordinate analysis are given in Table VI.

TABLE VI

Amide	Mode	Frequency (in cm^{-1})
Formamide	ν (C—N)	1309
Thioformamide	ν (C—N)	1325 and 1443
N-methylformamide	Amide III	1248
N-methylthioformamide	Amide III	1297
Dimethylformamide	ν (C—N)	1502
Dimethylthioformamide	ν (C—N)	1540

On the basis of computations of potential energy distribution of each normal mode among various symmetry co-ordinates, the bands at 1443 cm^{-1} and 1325 cm^{-1} in thioformamide are considered as due to the combined contribution of ν(C–N) and δ(C–H) vibrations. It is seen from Table VI that the C–N stretching frequencies in thioamides are higher than of those in the corresponding amides. In addition, the observations in Table III indicate that the intensities of the N–H stretching absorption bands of N-methylthioamides are much higher than those of the corresponding N-methylamides.

The experimental results of higher C–N stretching frequencies, higher values of the intensities of N–H stretching absorption bands and greater values for the rotational barriers in thioamides than in the corresponding amides thus lead to a basic and important conclusion that the double bond character of the C–N bond in thioamides is greater than that in the corresponding amides.

---

1. Ladell, L. and Post, B., *Acta Cryst.*, 1954, **7**, 559.
2. Kurland, R. J., *J. Chem. Phys.*, 1955, **23**, 2202.
3. Costain, C. C. and Dowling, J. M., *Ibid.*, 1960, **32**, 158.
4. Romers, C.., *Acta Cryst.*, 1953, **6**, 429.
5. Ayarst, E. M. and Duke, J. R. C., *Ibid.*, 1954, **7**, 588.
6. Morris, R. E. and Orville-Thomas, W. J., *J. Mol. Spectry.*, 1961, **4**, 572.
7. Suzuki, I., *Bull. Chem. Soc., Japan*, 1960, **33**, 1359.
8. —, *Ibid.*, 1962, **35**, 540.
9. Venkata Chalapathi, V. and Venkata Ramiah, K., *Proc. Ind. Acad. Sci.*, 1968, **68**, 109.
10. —. and —, *J. Mol. Spectry.*, 1968, **26**, 444.
11. Barrow, G. M., *J. Chem. Phys.*, 1953, **21**, 2008.
12. Usha Bai, P. and Venkata Ramiah, K., *Bull. Chem. Soc.. Japan*, 1971, **44**, 373.
13. Elliot, J. J. and Masan, S. F., *J. Chem. Soc.*, 1959, p. 1275.
14. Cannon, C. G.. *J. Chem. Phys.*, 1956, **24**, 491.
15. —, *Michrochim. Acta*, 1955, **2**, 555.
16. Rogers, M. T. and Woodbrey, J. C., *J. Phys. Chem.*, 1962, **66**, 540.
17. Loewenstein, A., Malera, A., Rigny, P. and Walters, W., *Ibid.*, 1964, **68**, 1597.
18. Newman. Jr., R. C. and Young, L. B., *Ibid.*, 1965, **69**, 2570.
19. Rabonovitz, M. and Pines, A., *J. Amer. Chem. Soc.*, 1969, **91**, 1585.
20. Evans, J. C., *J. Chem. Phys.*, 1954, **22**, 1228.
21. Lumley Jones, R., *J. Mol. Spectry*, 1963, **11**, 411.
22. Suzuki, I., *Bull. Chem. Soc., Japan*, 1962, **35**, 1286.
23. —, *Ibid.*, 1962, **35**, 1449.
24. Indirachary, C. A. and Venkata Ramiah, K., *Proc. Ind. Acad. Sci.*, 1969, **69**, 18.

EFFECT OF O_2 ON N_2 AFTERGLOW

A. N. SRIVASTAVA, R. V. SHUKLA AND S. K. GUPTA
J.K. Institute of Applied Physics and Technology, University of Allahabad, Allahabad, India

ABSTRACT

Effect of molecular oxygen on the afterglow of nitrogen has been studied photometrically in a dynamical flow system at room temperature. Using large O_2 concentrations, it has been found that intensity of the afterglow decreases linearly with partial pressure of O_2. To account for the decrease in intensity, the three-body reaction

$$N + N + O_2 \rightarrow N_2' + O_2$$

is proposed and its rate coefficient is estimated to be $3{\cdot}22 \times 10^{-34}\ \mathrm{cm}^6\ \mathrm{sec}^{-1}$.

1. INTRODUCTION

N_2 first positive bands were first detected in the afterglow of nitrogen by Fowler and Strutt.[1] Detailed studies of these bands, their excitation mechanism and the effect of various physical factors were carried out later on.[2-5] Kistiakowsky and Volpi[6] and Mavroyannis and Winckler[7] observed that O_2 has practically no effect on N_2 first positive system at room temperature. At higher temperatures, O_2 molecules react with N atoms and consequently the intensity of these bands decreases with O_2 concentration. In these experiments, the concentration of O_2 molecules used was small. In order to find out whether molecular oxygen has at all any effect on N_2 first positive bands, large amount of O_2 gas was used in the present investigation.

2. PROCEDURE AND OBSERVATIONS

The experimental arrangement used was the same as in the earlier work.[8] For the production of N_2 afterglow, N atoms were produced by dissociating molecular tank nitrogen by a Raytheon microtherm. Flow of O_2 and N_2 gases were varied by Hoke Needle valves. Pressure inside the reaction chamber was measured by a NRC thermocouple gauge. The experiment was performed at room temperature.

To obtain an intense afterglow, tank N_2 was introduced into the evacuated system through a needle valve. Before entering the reaction chamber, it was partly dissociated by the microtherm discharge. As the pressure of N_2 was gradually increased, the reaction chamber began to fill up with straw-yellow afterglow. At 0·315 torr, a workable intensity of the afterglow was obtained. To study the intensity of N_2 first positive bands photometrically, the (11, 7) band at 5804 Å was picked up with the help of a Bausch and Lomb grating monochromator. Tank O_2 gas was introduced into the reaction chamber through another needle valve and its pressure was gradually varied upto 0·15 torr. It was observed that the intensity of the band goes on decreasing with O_2 concentration. The ratio I_{N+O}/I_N was plotted against O_2 concentration, where I_{N+O} and I_N denote intensities of the band at 5804 Å with and without O_2 gas respectively. The curve is a straight line intersecting the ordinate at unity (Fig. 1).

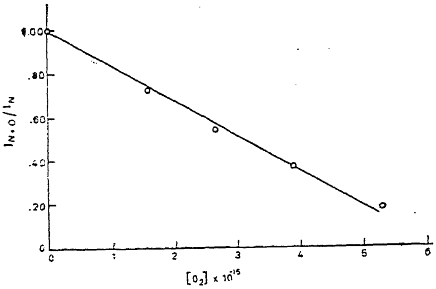


FIG. 1. Variation of I_{N+O}/I_N against O_2 concentration.

3. DISCUSSION

The N atoms are produced by the microtherm discharge as follows:

$$N_2 \xrightarrow{k_1} N + N. \tag{1}$$

These atoms may be lost as follows:

$$N + N + M \xrightarrow{k_2} N_2^* + M \tag{2}$$

$$N + N \xrightarrow{k_3} N_2^*. \tag{3}$$

At equilibrium, one gets

$$k_1 [N_2] = k_2 [N]^2 [M] + k_3 [N]^2. \tag{4}$$

In equations (2) and (4), M stands for N_2 molecules. As two body reactions are unimportant for pressure $> 0\cdot08$ torr,[9] the last term in equation (4) is neglected. Also, the loss of N atoms at the wall is small.[10] Hence, the equation (4) takes the form:

$$k_1 [N_2] = k_2 [N]^2 [M]. \tag{5}$$

Excited N_2 formed in reaction (2) may be lost as follows:

$$N_2^* \xrightarrow{A} N_2 + h\nu, \text{ (N}_2\text{ First Positive Bands)} \tag{6}$$

$$N_2^* + M \xrightarrow{k_7} N_2 + M', \tag{7}$$

$$N_2^* + \text{wall} \xrightarrow{k_8} N_2 + \text{wall}'. \tag{8}$$

From equations (5), (6), (7) and (8), the volume emission rate I_N of N_2 first positive bands, after neglecting the wall effect,[10] is given by:

$$I_N = \frac{k_1 [N_2]}{1 + \frac{k_7}{A} [M]} = \frac{k_2 [N]^2 [M]}{1 + \frac{k_7}{A} [M]} \tag{9}$$

$k_7/A\,[M]$ in the equation (9) may be neglected[11] as concentrations of $N_2 = M$ used here are small. Hence,

$$I_N = k_1 [N_2] = k_2 [N]^2 [M]. \tag{10}$$

When O_2 molecules are introduced into the reaction chamber, N atoms may be also lost by the following process:

$$N + N + O_2 \xrightarrow{k_{11}} N_2' + O_2'. \tag{11}$$

From equations (5) and (11), one gets,

$$k_1 [N_2] = k_2 [N]^2 [M] + k_{11} [N]^2 [O_2]. \tag{12}$$

Now, the new volume emission rate I_{N+O} of N_2 band at 5804 Å is given by:

$$I_{N+O} = k_1 [N_2] - k_{11} [N]^2 [O_2]. \tag{13}$$

Making use of equations (10) and (13), one obtains:

$$\frac{I_{N+O}}{I_N} = 1 - \frac{k_{11}}{k_2} \frac{[O_2]}{[M]}. \tag{14}$$

At a fixed flowrate of N_2 gas, the ratio I_{N+O}/I_M in equation (14) varies linearly with O_2 concentration. This is in agreement with observations presented in Fig. 1. From the slope of the curve in Fig. 1, one gets the value of $k_{11}/k_2[M]$. Using the value of k_2, as determined by Young and Black,[11] the value of k_{11} is estimated to be $3\cdot22 \times 10^{-34}$ cm^6 molecules sec.

---

1. Fowler, A. and Strutt, R. J., *Proc. Roy. Soc.*, 1918, **85 A**, **377**.
2. Strutt, R. J., *Ibid.*, 1917, **93 A**, 254.
3. Kaplan, J., *Phys. Rev.*, 1939, **55**, **606**.
4. Berkowitz, J., Chupka, W. A. and Kistiakowsky, G. B., *J. Chem. Phys*, 1956, **25**, **457**.
5. Gross, R. W. F., *Ibid.*, 1968, **48**, 1302.
6. Kistiakowsky, G. B. and Volpi, G. G., *Ibid*, 1957, **27**, **1141**.
7. Mavroyannis, C. and Winckler, C. A., *Chemical Reactions in the Lower and Upper Atmosphere*, Interscience Publishers, New York and London, 1961.
8. Ghosh, S. N., Srivastava, A. N. and Shukla, R. V., *Ann. Geophys.*, 1970, **26**, **59**.
9. Bernard, J. W. and Wise, H., *J. Phys. Chem.*, 1962, **66**, 1049.
10. Shukla, R. V., Jain, S. K., Gupta, S. K. and Srivastava, A. N., *J. Chem. Phys.*, 1970, **52**, **2744**.
11. Young, R. A. and Black, G., *Ibid.*, 1966, **44**, **3741**.

ERADICATION AND UTILIZATION OF WATER HYACINTH*

V. RAMACHANDRAN, T. RAMAPRABHU AND P. V. G. K. REDDY
Central Inland Fisheries Research Substation, Cuttack

THOUGH Jagadeesh and Lakshminarayana[1] have added some information on the use of 2, 4-D for the control of water hyacinth and the use of the plant for removal of nutrients from polluted waters to the original review by Sharma[2] the information given is still far from complete. 2, 4-D has been extensively used not only in America and Africa but also in many other parts of the world including India[3-32] for the eradication of water hyacinth. Philipose[33,34,36] and Chakravarty[37] have reviewed the work done in India on this problem. The cost of manual clearance and control by 2, 4-D have been compared by Philipose[35] and Ramachandran[26] and reasons for favouring chemical control are adduced. Physical removal of water hyacinth depletes the medium of all nutrients that have been robbed from it by the dense infestation. A possible increase in nutrients like phosphate after killing and disintegration of water hyacinth by 2, 4-D has been indicated in Indian ponds.[55] A simple and economically feasible technique for the treatment of even the densest infestation has been evolved[26,27] and this has been recently adopted by municipal authorities at Cuttack. Besides 2, 4-D, and M.C.P.A., Silvex, a formulation of 2-(2, 4, 5-trichlorophenoxy) propionic acid,[36,47] Diquat, Amitrole-T,[22,23,25,32,39,47] and Simazine[26] have also been effectively used in controlling this weed. 2, 4, 5-T was found to be more effective than 2, 4-D[24] though Hitchcock *et al.*[46] found the reverse to be true. Recently, aqueous ammonia applied at the root zone was found to kill the plants totally (Central Inland Fisheries Research Institute Report, 1968 and 1969).

Biological control by the weevil, *Neochetina bruchi*, stem-borers *Aciqona ignitalis* and *Epipaqis albiquttalis*, aquatic grasshopper, *Cornops longicorne* and the mite *Leptogalumna* are reported to be promising.[40] Bennett and Zwolffer[40] refer to work done by Rao and Sankaran in India in this direction. Attempts to control *Eichhornia crassipes* by the snail *Marisa cornuarieties* have proved only partly successful.[41] Attempts have been made for controlling water hyacinth by use of fish like grass carp (*Ctenopharyngodon idella*), *Tilapia melanopleura*,[49-52] and also for using it as feed for fish.[49,53,54]

The utilization of water hyacinth for nutrient removal was first demonstrated by Sheffield[42] as a practical means of eliminating nitrogen and phosphorus before they are effluented into watercourses. He developed a pilot plant consisting of an 'aquatic plant pond' with water hyacinth, an air stripping unit and a flocculation and settling unit. The removal of nitrogen and phosphorus in the above process was far superior to that of an algal pond studied for comparison as seen in Table I.

TABLE *I*

Type of process	Nitrate-N		Ammonia-N		Phosphate	
	Final effluent conc.	Per cent. removal	Final effluent conc.	Per cent. removal	Final effluent conc.	Per cent. removal
*Algal pond effluent	5·0 mg/l	67	7·0 mg/l	88	1·0 mg/l	99
†Aquatic pond effluent	0·2 mg/l	99	0·1 mg/l	99*	0·7 mg/l	99*
Difference in processes	4·8 mg/l	33	6·9 mg/l	11	0·3 mg/l	0

* Max. removal, † Average removal. (From Sheffield, 1967).

Taylor and Robins[43] have determined the amino-acid composition of water hyacinth and found that its lysine content is sufficient to improve a corn diet. The following levels of essential amino-acids in 100 g of crude protein were recorded by them:

Methionine ..	.. 0·72 g
Phenylalanine ..	.. 4·72 g
Thremine ..	.. 4·32 g
Lysine ..	.. 5·34 g
Isoleucine ..	.. 4·32 g
Valine ..	.. 0·27 g
Leucine ..	.. 7·20 g

They reported also that higher protein levels were found in June and July and younger plants are richer in protein. According to Waterlow as quoted by Taylor and Robbins,[43] biological value of leaf protein of water hyacinth is reported to be equal to that of milk. The crude protein content of water hyacinth has been estimated to be 12-18% dry weight and 1·1% wet weight.[44] Van Vuran[45] estimated that under suitable climatic conditions, one acre of water hyacinth would remove 3,075 pounds of nitrogen per year. Singh[48] has tried its use as a compost for growing vegetables and found that its phosphorus content is higher than in composts of other aquatic weeds.

---

* Published with the kind permission of Director, Central Inland Fisheries Research Institute, Barrackpore.

---

1. Jagadeesh, K. M. and Lakshminarayana, C. S., *Curr. Sci.*, 1971, **40** (7), 148.
2. Sharma, A., *Ibid.*, 1971, **40** (3), 51.
3. Ahlgreen, G. H., Klingman, G. C. and Wolf, B. E., *Principles of Weed Control*, John Wiley & Sons, New York, Chapman & Hall Ltd., London, 1951, p. 368.
4. Long, H. C. and Brenchley, W. E., *Suppression of Weeds by Fertilizers and Chemicals*, Crosy Lockwood & Son Ltd., 1949.
5. de Ong, E. R., *Insect, Fungus and Weed Control*, Chemical Publishing Co., Inc., N.Y., 1963, p. 400.
6. Kar, B. K., *Sci. & Cult.*, 1947, **12** (11), 545.
7. Mitra, G. P., *Ibid.*, 1948, **14** (4), 143
8. Padwick, G. W., *Indian Farming*, 1948, **9** (12), 497.
9. Joshi, L. M., Pantulu, V. R. and Padmanabhan, S. Y., *Ibid.*, **11**, 545.
10. Tin, U. P., Baruah and Baruah, H. K., *Sci. & Cult.*, 1949, **15** (3), 106.
11. Singh, S. B., *Proc. 49th Ind. Sci. Congr., Absts.*, Part III, No. 107, 393.
12. Sen, A. C., *Sci. & Cult.*, 1957, **23**, 315.
13. Saha, K. C., Sen, D. P. and Muhury, G. N., *Ibid.*, 1958, **23** (10), 556.
14. Baruah, H. K., Das, N. and Baruah, P., *J. Univ. Gauhati*, **6**, 103.
15. Ball, E. W., *Proc. of the Thirteenth Annual Conf. S.E. Assn. Game and Fish Commrs.*, Baltimore, Maryland, 1959, p. 259.
16. Lawrence, J. M. and Geagan, D. W., *Proc. of the S.E. Assn. Game and Fish Commrs.*, New Orleans, Louisiana, 1954, p. 114.
17. Surber, E. W., *U.S. Dept. of Interior, Fish and Wildlife Service Fishery Leaflet*, 1949, **344**, 20.
18. Menon, C. T., *Prog. Fish Cult.*, 1965, **27** (4), 228.
19. Smolka, H., *Weed. Abstr.*, 1964, **13** (4), 1085, 202.
20. Vaas, K. F., *Contr., Gen., Agr. Res. Sta. Bogor.*, Indonesia, 1951, **120**, 1.
21. Lawrence, J. M., *Progr. Fish Cult.*, 1955, **17** (3), 141.
22. Stephens, J. C. *et al.*, *J. Irr. and Drain Divn.* ASCF., 1963, **89**, No. IR2, 31.
23. Harrison, D. S., *Aquatic Weed Control*, Univ. of Florida Agr. Extn. Ser. Circular 219A, 1964, p. 16.
24. Misra, G. and Das, N., *Hyacinth Control J.*, 1969, **8**, 22.
25. Blackburn, R. D. and Weldon, L. W., *Suggeste Control Measures for Common Aquatic Weeds o Florida*, U.S. Dept. of Agric., ARS, C.R.A., For Lauderdale, Florida, 1963. p. 9 (Mimeo).
26. Ramachandran, V., *Report on the Infestation Water Hyacinth in Marikollong Bheel (Newgong Assam) with Recommendations for its Eradicatio* Bull. No. **2**, C.I.F.R.I., Barrackpore, (*Vi* Calcutta), 1963, p. **13** (Mimeo).
27. — and Ramaprabhu, T., *FAO Fish Repts. No.* **4** 1968, **5**, 92.
28. —, *Indian Fmg.*, 1969, **19** (9), 75.
29. Pickworth, G., *Fmq., S. Africa*, 1969, **45** (3), 13.
30. Green, K. P., *Agric. Gaz. N.S.W.*, 1969, **80**, (11 628.
31. Bauer, S., *Agric. Aviat.*, 1968, **8** (4), 116.
32. Dawood, D. L. *et al.*, *Bull. W.H.O.*, 1965, **3** 269.
33. Philipose, M. T., *A Report on the Present Status Aquatic Weed Control in the Indo-Pacific Countrie* IPFC/C.57/UP (25), 1957, p. 16 (Mimeo).
34. —, *Some Practical Hints for the Control of Comm Aquatic Weeds in Fishery Waters of Indi* C.I.F.R. Station, Barrackpore, West Beng 1959, p. 12 (Mimeo).
35. —, *Indian Livestock*, 1963, **1** (2), 20, 34.
36. —, *FAO Fish Repts. No. 44*, 1968, **5**, 26.
37. Chakravarty, S. C., *Indian Agric.*, 1963, **8** (1/2), 1
38. Thomptson, W. W., Pierce, P. C. and Wyatt, H. *Proc. 13th Ann. Conf. S.E. Assn. Gameand Fi Commrs.*, Baltimore, Maryland, 1959, 101.
39. Blackburn, R. D. and Weldon, L. W., *Weed Abst* 1964, **13** (2), 440.
40. Bennett, F. D. and Zwolffer, H., *Hyacinth Control* 1968, **7**, 44.
41. Seaman and Porterfield, *Weeds*, 1964, **12** (2), 87.
42. Sheffield, C. W., *Hyacinth Control J.*, 1967, **6**,
43. Taylor, K. G. and Robbins, R. C., *Ibid.*, 1968, **7**,
44. Claude, E., Boyd, *Ibid.*, 1968, **7**, 26.
45. Van Vuran, J. P. J., *Soil Fertility and Sewage*, Do Publications, New York, 1948.
46. Hitchcock *et al.*, *Boyce Thompson Inst.*, 1950, **16**,
47. Blackburn, R. D., *FAO Fish Repts. No. 44*, 19 **5**, 1.
48. Singh, S. B., *IPFC, Proc.*, 1962, Sec. II, 141.
49. — *et al.*, *Ibid.*, 12 (II), 220.
50. Avault, J. W., Jr., *Proc. 18th Ann. Meet. S. W Conf.*, 1965, Dallas, Texas.
51. —, *Progr. Fish Cult.*, **27** (4), 207.
52. —, Smitherman, R. O. and Shell, E. W., *FAO F Repts. No. 44*, 1968, **5**, 109.
53. Ling, S. W., *Internat. Inland Fish. Training Cen* Indonesia, FAO Publ., 1955, **1**, 3. **23**, **12**.
54. —, *FAO Fish Repts. No. 44*, 1968, **3**, 291.
55. *Annual Report of Central Inland Fisheries Resea Institute*, Barrackpore, 1970.

MOLECULAR WEIGHTS OF CHOLINESTERASES FROM THE INDIAN HONEY BEE *APIS INDICA*, HOUSE FLY *MUSCA DOMESTICA* AND THE DESERT LOCUST *SCHISTOCERCA GREGARIA*

D. DALE* AND K. N. MEHROTRA

Division of Entomology, Indian Agricultural Research Institute, New Delhi-12

ABSTRACT

The molecular weights of Cholinesterases (ChE's) from the head homogenates of honey bee, house fly and the desert locust were determined by gel filtration on Sephadex G-200. The results indicate that both honey bee and locust ChE's have a molecular weight of around 82,000 while the house fly ChE has a molecular weight of 165,200. In all the runs, the acetyl-ChE came as a first peak indicating that the enzyme is also present as a very high polymer with a molecular weight running to millions.

CHOLINESTERASE (ChE) of insects has been a subject of great interest from toxicological and kinetic points of view. Efforts to date to purify the enzyme from insect sources have only been moderately successful. As a consequence of the lack of success in the purification trials, there is a paucity of knowledge on the molecular properties of this enzyme. The present report describes experiments aimed at the estimation of molecular weights of ChE's from the Indian honey bee, house fly and the desert locust.

ChE's used in the present investigation were obtained from the heads of honey bee, house fly and the desert locust. The tissues were homogenized in an all-glass Potter-Elvehjem type homogenizer with ice-cold phosphate buffer of pH 7·0 ($NaCl = 26 \cdot 3$ g, $KH_2PO_4 = 3 \cdot 85$ g, $NaOH = 1 \cdot 0$ g and water to make 1 litre). The homogenates were centrifuged for 10 minutes at 6,000 rpm in a refrigerated centrifuge at 0° C. The supernatants were collected and used in the gel filtration studies.

A 2·5 cm × 45 cm K 25/45 column (Pharmacia Fine Chemicals, Uppsala, Sweden) was set with Sephadex G-200 (Pharmacia Fine Chemicals) which was previously swollen in phosphate buffer. The buffer used for homogenization was diluted ten times with 0·5 M NaCl and used in the columns. The dead volume (V_0) of the column was determined before each experiment by running Blue Dextran-2000. The column was standardised by running proteins of known molecular weights like γ-globulin (human), serum-albumin (bovine) and myoglobin; and was found to obey the regression equation proposed by Determann and Michel (1966). The volume of homogenate put on to the column was 2 ml for each experiment. An automatic siphoning system was employed to collect 3 ml fractions.

ChE activity in the fractions was estimated using acetylthiocholine bromide (ATChBr) (Ellman *et al.*, 1961; and Smissaert, 1964), indophenyl acetate (IPA) (Kramer and Gamson, 1958) and orthonitrophenyl acetate (ONPA) (Main *et al.*, 1961) as substrates.

Figure 1 shows the ChE activity of various fractions collected from the run using honey bee homogenate. A large portion of the enzyme eluted out at or near the dead volume (84 ml). There was a second peak when the elutes were tested with IPA and ONPA as substrates; but this was not discernible with ATChBr. The molecular weight of ChE in peak II was calculated to be 82,040.

Figure 2 depicts the pattern of distribution of enzyme activity, in the run with house fly homogenate, when determined using IPA as substrate. As with the honey bee, here also the first peak came out at the dead volume (84 ml) of the column. The molecular weight of ChE in the second peak was found to be 165,200.

Figure 3 gives the pattern of ChE activity in locust homogenate when the fractions were tested for the enzyme with IPA as the substrate. It is clear from the figure that in this case also there were two peaks—the first almost at the dead volume and the second around the 43rd fraction. The molecular weight of locust ChE eluted out as the second peak amounted to 82,410.

It is apparent from a perusal of the literature relating to the molecular weight of ChE that the enzyme appears in many polymer forms or aggregates; this is clearly indicated for eel ChE in the reports of Lawler (1963) and Kremzner and Wilson (1964). The results of the present studies also give credence to the above assumption. It can be presumed that the monomer unit of ChE has a molecular weight around 82,000. It is clear from the results that the ChE's from honey bee and the desert locust exist as their basic units in the elutes of the second peak while the enzyme from house fly in the same peak seems to be a dimer with a molecular weight of 165,000. Krysan and Chadwick (1966) reported the molecular weight of house fly ChE to be approximately equal to 160,000.

---

* Present address: Division of Entomology, Agricultural College, Vellayani P.O., Kerala.

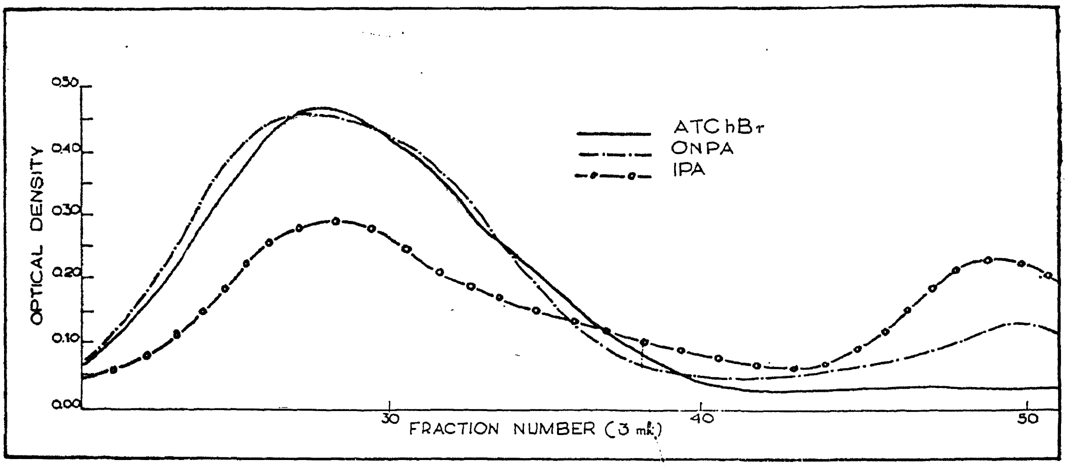


FIG. 1. Pattern of ChE activity from the run with honey bee homogenate.

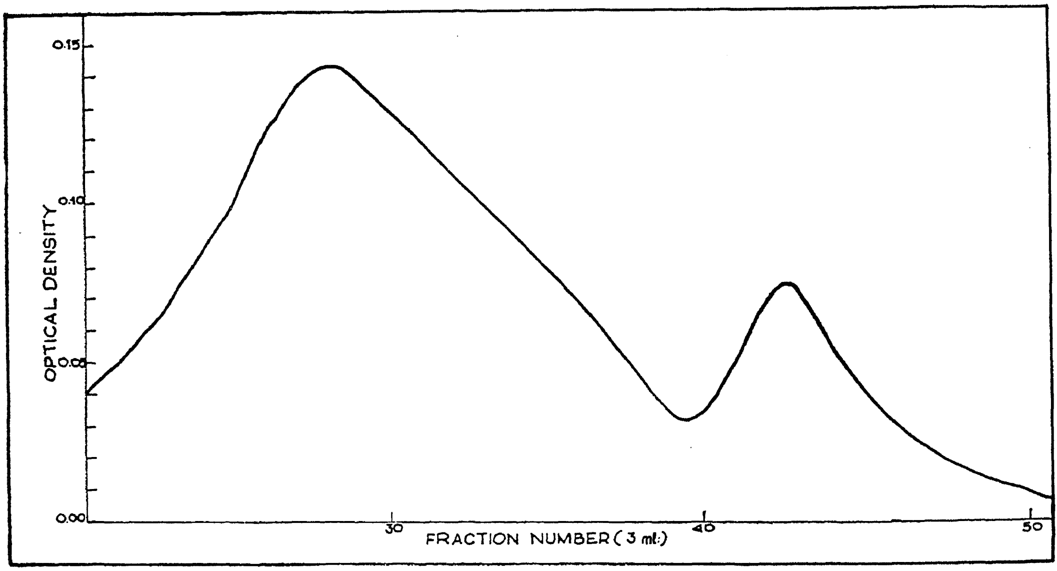


FIG. 2. Distribution of ChE activity in the run with house fly homogenate when determined using IPA as substrate.

There were distinct peaks at the dead volume in all the three insect species, indicating clearly that the enzyme is also present as a high polymer with a molecular weight running to millions. Kunkee and Zweig (1963) also reported the molecular weight of ChE from *Apis mellifera* to be "in millions"; their enzyme preparation could well be considered as an agglomerate of basic units and to be simulating the nature of the enzyme in the first peak of our studies.

Evidence has also been obtained from the present investigations that the honey bee ChE in the second peak is not of the 'true ChE' type because the second peak did not emerge with ATChBr as the substrate. Hence, this peak may be comprised solely of aliphatic and aromatic esterases. It can also be inferred that most of the acetyl-ChE in the homogenates came out in the first peak.

ACKNOWLEDGEMENTS

Thanks are due to Dr. S. Pradhan, Head of the Division of Entomology, Indian Agricultu-

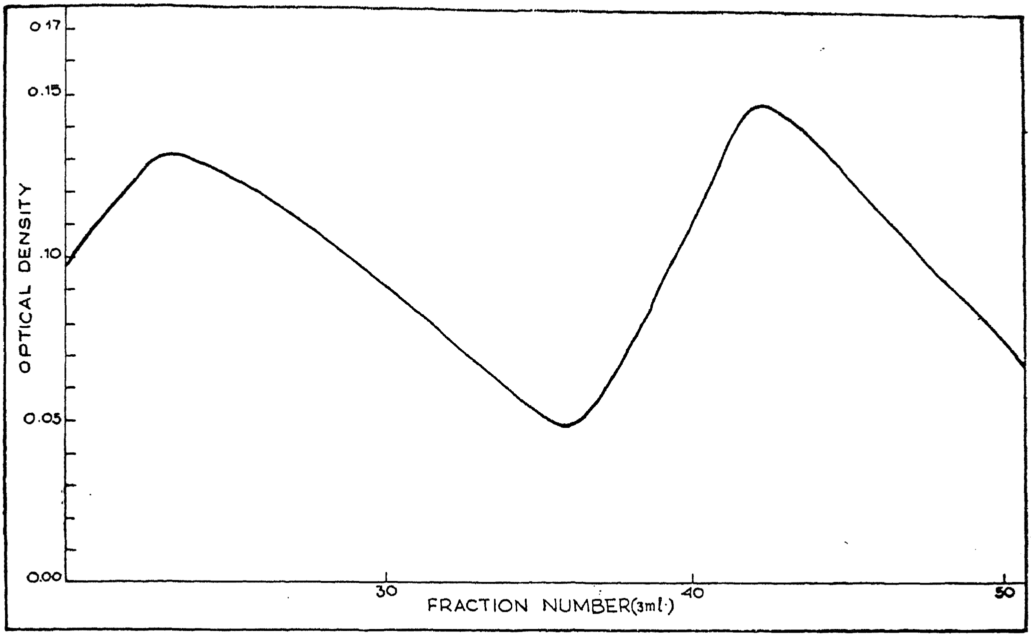


FIG. 3. Pattern of ChE activity in locust homogenate when the fractions were tested for the enzyme with IPA as substrate.

ral Research Institute, New Delhi, for taking keen interest in this study and for providing the laboratory facilities. Grateful thanks are also due to the Council of Scientific and Industrial Research, New Delhi, for offering a Research Fellowship to one of the authors (D. D.) that supported this work.

---

1. Determann, H. and Michel, W., *J. Chromat.*, 1966, **25**, 303.
2. Ellman, G. L., Courtney, D., Andres, V., Jr. and Eatherstone, R., *Biochem. Pharmac.*, 1961, **7**, 88.
3. Kramer, D. N. and Gamson, R. M., *Annal. Chem.*, 1958, **30**, 251.
4. Kremzner, L. T. and Wilson, I. B., *Biochemistry*, 1964, **3**, 1902.
5. Krysan, J. L. and Chadwick, L. E., *J. Ins. Physiol.*, 1966, **12**, 781.
6. Kunkee, R. E. and Zweig, G. J., *Ibid.*, 1963, **9**, 495.
7. Lawler, C. H., *J. Biol. Chem.*, 1963, **238**, 132.
8. Main, A. R., Miles, K. E. and Braid, P. E., *Biochem. J.*, 1961, **78**, 769.
9. Smissaert, H. R., *Science*, 1964, **143**, 129.

POLYTECHNIC INSTITUTE OF BROOKLYN INTERNATIONAL SYMPOSIUM XXII—“COMPUTER-COMMUNICATIONS NETWORKS AND TELETRAFFIC”

THE Polytechnic Institute of Brooklyn announces that the twenty-second in its Microwave Research Institute Series of Annual International Symposia will be on the topic of Computer-Communications Networks and Teletraffic. This Symposium will be held on 4-6 April 1972 in New York City.

Professor R. L. Pickholtz and Professor R. R. Boorstyn, Co-Chairmen of the M.R.I. Symposium Committee, will welcome contributed papers up to the deadline of 1 December 1971. For consideration, a 500-word abstract should be submitted with sufficient detail to describe results and methods for proposed papers. Selection of papers will be facilitated by inclusion of explanatory material and/or essential results as appropriate. The complete manuscript must be provided by the time of the Symposium.

Please address all correspondence and inquiries to: Polytechnic Institute of Brooklyn, M.R.I. Symposium Committee, 333, Jay Street, Brooklyn, N.Y. 11201, Attn.: Jerome Fox, Executive Secretary, Telephone (212) 643-2393.

LETTERS TO THE EDITOR

2-HYDROXY-5-METHYL ACETOPHENONE AS AN ANALYTICAL REAGENT FOR IRON (III)

Gupta and Malik[1] reported on the complexes of U (VI) and Th (IV) with 2-hydroxy-5-methyl acetophenone as reagent. In the course of investigations on o-hydroxy carbonyl compounds as inorganic analytical reagents, the present author found that this reagent gave a stable violet-blue colour with ferric iron at pH 1·5 to 2·2 and an orange-brown colour at pH 3·5 to 6·5. Beryllium gave a green fluorescence under filtered ultraviolet light. No colour or fluorescence was observed with Hg^{2+}, Pb^{2+}, Mn^{2+}, Zn^{2+}, Al^{3+} and Ti^{4+}. The limits of identification and dilution for the reaction with ferric ions were found to be 0·5 γ and $1 : 10^5$ respectively. The iron complex exhibited maximum absorption at 400 mμ in the pH range 1·5 to 2·2. The colour reaction obeyed Beer's Law in the range 5 to 40 ppm.

The molar composition of the complex determined by Job's method of continuous variation[2] was found to be, reagent: ferric iron as 3 : 1. This was confirmed by the slope ratio method of Harvey and Manning.[3] The instability constant of the complex determined by the method of Edmonds and Birnbaum[4] was found to be $4·726 \times 10^{-10}$ (average).

The author wishes to thank Prof. K. Neelakantam for his kind interest in the work.

Dept. of Chemistry. K. Adinarayana Reddy.
S.V. University College,
Tirupati (A.P.), *March* 9, 1971.

---

1. Gupta, B. D. and Wabid, U. Malik., *J. Ind. Chem. Soc.*, 1970, **47**, 145.
2. Job, P., *Ann. Chim.*, 1928, 9 (10), 113.
3. Harvey, A. E. and Manning, D. L., *J. Am. Chem. Soc.*, 1950, **72**, 4488.
4. Edmonds, S. M. and Birnbaum, N., *Ibid.*, 1941, **63**, 1471.

ULTRASONIC STUDIES IN FATTY ACIDS

Measurements of ultrasonic velocity and temperature coefficient of liquids are of valuable help in the study of molecular structure. Many workers[1–3] studied different liquids from this point of view and made notable contributions. A few fatty acids were studied from the point of view of ultrasonic dispersion by Wada, Simbo and Oda,[4] and by Hiedemann and his co-workers.[5] The results of these two groups of workers, however, do not agree.

In view of the scanty and controversial data available, it seemed worthwhile to extend the ultrasonic and temperature coefficient measurements to a series of fatty acids that are available. Ultrasonic measurements have been accordingly carried out using the composite ultrasonic interferometer[6] designed in this laboratory.

The interferometer essentially consists of two matched quartz crystals of fundamental frequency 1 Mc/s dipped in the test liquid of about 200 ml. One of them serves as transducer and the other as detector. The transducer is excited by a variable frequency oscillator and the response is observed by an R.F. millivoltmeter connected across the detector. The distance between the two crystals can be adjusted to a suitable value. The resonant frequencies of the liquid column as well as the half wavelengths can be measured by noting the successive peaks of the R.F. millivoltmeter, by operating this interferometer either as fixed or variable path type. The frequency is measured to an accuracy of 0·01 Kcps and the half wavelengths upto 0·0005 cm. The temperature of the test liquid is controlled to ± 0·1° C with an electronically controlled toluene regulator. The liquid is continuously stirred with a magnetic stirrer to attain thermal stability.

Using the above interferometer, the ultrasonic velocities and the temperature coefficients obtained for a number of fatty acids are listed in Ttble I.

Table I
Ultrasonic velocities and temperature coefficients of fatty acids

Liquid		Formula	Mol. weight	Velocity at 69·5° C. (m/sec.)	Temperature coefficient $(-\Delta c/\Delta t)$
Acetic acid	..	$C_2H_4O_2$	60·03	961	3·74
Propionic acid	..	$C_3H_6O_2$	74·08	1006	3·60
n-Butyric acid	..	$C_4H_8O_2$	88·10	1042	3·55
N-Valeric acid	..	$C_5H_{10}O_2$	102·13	1063	3·47
Capric acid	..	$C_{10}H_{20}O_2$	172·26	1201	3·32
Lauric acid	..	$C_{12}H_{24}O_2$	200·31	1215	3·25
Myristic acid	..	$C_{14}H_{28}O_2$	228·36	1266	3·24
Palmitic acid	..	$C_{16}H_{32}O_2$	256·42	1270	3·16
Stearic acid	..	$C_{18}H_{36}O_2$	284·47	1277	3·08

A plot of the ultrasonic velocity against molecular weight is shown in Fig. 1. It is clear that the ultrasonic velocity increases with the molecular weight of the acid; the increase being very rapid upto a molecular weight of 200. As one goes to higher molecular weights further increase in velocity is gradual and small, approaching a maximum value of 1300 m/sec.

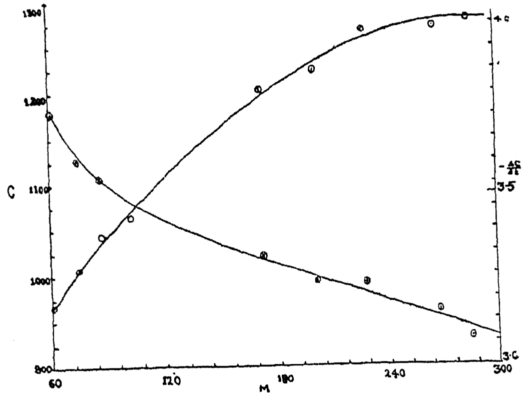


FIG. 1. Variation of velocity and temperature coefficient with molecular weight.

Figure 1 also shows a plot of temperature coefficients against molecular weight of the acid. It is interesting to note that the temperature coefficient decreases with the molecular weight; the decrease is very rapid upto a molecular weight of 100, thereafter the fall is very gradual. A plot of the product $c.\Delta c/\Delta t$ against molecular weight is shown in Fig. 2. For the fatty acids studied, a point of inflection is observed corresponding to a molecular weight of 228. Thus it is seen that the product $(M^{\frac{1}{2}}.\Delta c/\Delta t)$ is not a constant for the series of fatty acids studied, as in the case of normal liquids.

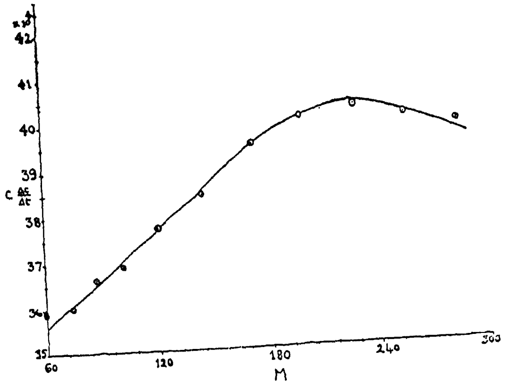


FIG. 2. Variation of $c.\Delta c/\Delta t$ with molecular weight.

Dept. of Physics, C. RAGHUPATHI RAO.
Osmania University, P. S. R. KRISHNA RAO.
Hyderabad-7, *March* 5, 1971.

---

1. Rama Rao, M., *J. Chem. Phy.*, 1941, **9**, 682.
2. Lagemann, R. T., MacMillan, D. R. Jr. and Woolf, W. E., *Ibid.*, 1948, **16**, 247.
3. —, — and —, *Ibid*., 1949, **17**, 369.
4. Wada Simbo and Oda, *J. Phys. Soc., Japan*, 1950, **5**, 345.
5. Mayer, W. G. and Hiedemann, E. A., *J. Acoust. Soc. Am.*, 1956, **28**, 649.
6. Rao, C. R. and Rao, P. S. R. K. and Subramanyam, P., *Ind. J. Pure and App. Phys.*, 1968, **6**, 638.

SOME OBSERVATIONS OF *PENICILLIUM CITRINUM* TOXICITY

THE mold *Penicillium citrinum* has often been reported to be present in contaminated foodstuffs.[1,2] In our attempts to study toxic fungi belonging to the genus *Penicillium*, a strain of *P. citrinum* isolated from contaminated food was found to be toxic and the present report deals with some of our observations.

The mold was grown on Richard's liquid medium for 20 to 25 days and was then concentrated, from which 1 ml aliquots were used for animal experiments.

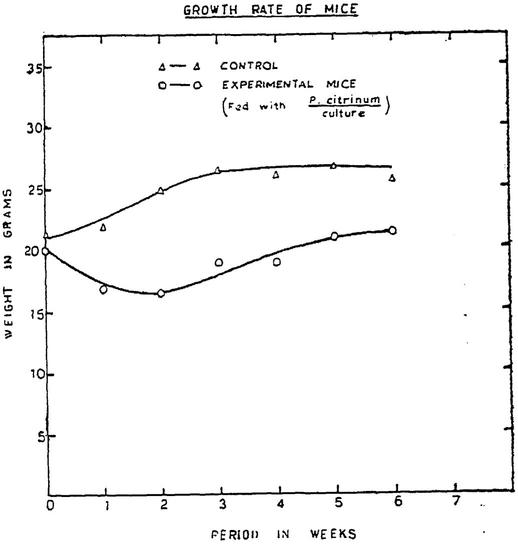


FIG. 1

Day-old chicks showed a mortality recording of 50% after single dose. Similar observation was noted in mice (25 days old, at the beginning of the experiment) during the 14th and 15th days of feeding. No mortality was observed in rats during the experimental period of 40 days. In all cases, growth retardation was observed (*e.g.*, mice, Fig.). This effect was seen in the case of rice-moth larvae, too. (*Corcyra cephalonica* St.).

The experimental animals were sacrificed at regular intervals for histopathological observations in liver and kidney. No visible macroscopic variations could be observed in the organs of the animals. Chick liver showed swollen cells, obliterating sinusoids and minimal necrosis of hepatic cells. Mouse liver showed mild hepatitis, hyperemia, lymphocytic infiltration around the blood-vessels and granularity of the cytoplasm of the hepatic cells with mild fatty changes. Biliary hyperplasia and thickening of bile channels could be seen in rat liver. Kidney of rats showed hyperemia, lymphocytic infiltration and focal intratubular hemorrhage in the medulla. Epithelial cells of the tubules were seen to have granular cytoplasm and swollen appearance. Changes due to chronic toxicity were observed which include fatty changes, thickening of the tubules and glomerular nephritis. The contaminated diet had a similar effect on rats. Aqueous and chloroform extracts of such a diet showed similar histological variations in chick liver.

Toxicity of *P. citrinum* polluted rice to rats has been reported where rats were found to die between 70 to 110 days.[3] Citrinin, a nephrotoxin, was found to be present in this diet. The production of citrinin by *P. citrinum* in liquid cultures has been reported, which is equivocal.[4-6] Certain pharmacological and toxicological activities of citrinin have been reported in mice, dogs, rats, guinea-pigs and rabbits.[7-9] Moreover, aflatoxin B_1 has also been found to be elaborated by two strains of *P. citrinum* out of the three tested.[10] These reports suggest the possibility of the implication of citrinin (a nephrotoxin) and aflatoxin B_1 (a hepatotoxin) in our toxicological results. However, the authors feel that there may be some other active principle(s) that could be attributed to the toxicosis observed. It is interesting to note that the toxicity observed in the species tested shows some significance. The mortality observed in day-old chicks after single dose was noted only after 14 days of feeding in the case of 25-days-old mice. This suggests a possible role of the toxic metabolite in the early developmental stage. The biphasic response of growth rate in mice and rats leads to some tentative conclusions : (*i*) The animals suffer from toxicosis during the first two weeks but appear to develop resistance as shown by the gain in weight, although lower than the controls ; (*ii*) The possibility of a bigger molecule such as a toxic (poly)peptide with antigenic property can well explain these observations. This rules out the possible implication of an already reported toxin (citrinin/aflatoxin B_1) in our observed toxicosis. Moreover, the acute toxicity of the *P. citrinum* culture to chicks, which the authors feel that this is the first report of its kind, strongly urges the search for some new toxic metabolite(s). However, the detection of citrinin and aflatoxin B_1 in our strain of *P. citrinum*, the quantification of the same and the roles enacted by them in our observations are being studied and will be reported later.

The authors wish to acknowledge thanks to Dr. (Mrs.) K. Radha Shanmugasundaram for her valuable suggestions and critical discussion. This work was sponsored and financed by the United States Department of Agriculture with PL-480 funds.

Univ. Biochem. C. DAMODARAN.
Laboratories, E. R. B. SHANMUGASUNDARAM.
A.C. College Buildings,
Madras-25, *February* 16, 1971.

---

1. Diener, U. L., *Phytopathology*, 1960, **50**, 220.
2. Brook, P. J. and White, E. P., *Ann. Rev. Phytopathol.*, 1969, **4**, **171**.
3. Nagai, J., Hayashi, M. and Mizobe, K., *Fukuoka-Igaku-Zasshi*, 1957, **48**, **311**.
4. Raistrick, H. and Smith, C., *Chem. Ind.*, 1941, **60**, 828.
5. Hetherington, A. C. and Raistrick, H., *Phil. Trans. Roy. Soc., London*, Ser. B, 1931, **220**, 269.
6. Wyllie, J., *Canad. J. Publ. Hlth.*, **1945**, **36**, **47**.
7. Ambrose, A. M. and De Eds, F., *J. Pharmacol.*, **1946**, **88**, **173**.
8. — and —, *Proc. Soc. Exptl. Biol. Med.*, 1945, **59**, 289.
9. Wei-chang, Chu, *Jour. Lab. Clin. Med.*, **1946**, **31**, **73**.
10. Kulik, M. M. and Holaday, C. E., *Mycopathol. Mycol. Appl.*, 1966, **30**, 137.

ORIENTATION OF VAT DYES IN CELLOPHANE ON SOAPING TREATMENT

IT is well known[1-3] that vat dyeing attain the stable shade by application of wet heat or treatment with hot detergent. Principally, there are three theories put forward to explain this observed phenomenon. First, it was thought to complete the process of oxidation.[1] According to the second theory,[2] the dye molecules on soaping form microcrystallites in interstitial cavities in the fibre. The treatment facilitates the physical migration of the dye which is necessary for crystal formation. According to the third hypothesis principally due to Wegmann,[3] the shade change is due to intramolecular polarization due to contact isomerization and does not involve any physical movement of the dye molecules. Visible dichroism, though showing a change in dichroism cannot decide between the last two theories because of the uncertainty of the direction of the transition moment and overlapping of different transitions which is quite likely in such a complex system. Infrared dichroism studies, before and after soaping, done here for the first time, give a more definite information.

Effect of soaping on the dichroism of carbonyl band in 1700 cm^{-1} region and aromatic C–H out of plane in 800 cm^{-1} region was studied on P.E. 21 spectrophotometer fitted with a wire grid polarizer. Differential technique was used. The results of infrared as well as visible dichroism of selected vat dyes are shown in Table I.

TABLE I

Dichroism of vat dyes

Class	Dye	Soaping treatment	C=O	C—H	Visible
1	C I. Vat Blue 20	Before	$\parallel$	$\perp$	$\parallel$
		After	$\perp$	$\parallel$	$\perp$
	C.I. Vat Yellow 2	Before	$\parallel$	—	$\parallel$
		After	$\perp$	—	$\perp$
2	C.I. Vat Orange 9	Before	$\perp$	$\parallel$	No
		After	$\perp$	$\parallel$	$\perp$
	C.I. Vat Green 1	Before	$\perp$	$\parallel$	$\parallel$
		After	$\perp$	$\parallel$	$\perp$
3	Benzamido derivative (C.I. Vat Orange 15)	Before	$\parallel$	No	$\parallel$
		After	$\parallel$	No	$\parallel$
4	Indigoid Dyes	Before	$\perp$	—	$\parallel$
		After	$\perp$	—	$\perp$

The two infrared bands chosen have transition moment in mutually perpendicular directions. The carbonyl band has transition moment along C=O band and in aromatic plane for a quinone carbonyl whereas C–H out of plane vibrations have transition moment perpendicular to the aromatic plane.

Table I shows that the dyes studied could be broadly divided into two classes. In the first class, the dichroism changes from parallel to perpendicular for carbonyl band and *vice versa* for C–H band. Since the transition moment of the bands are fixed with respect to the geometry of the molecule, it clearly shows that the direction of these groups has changed and the dye molecule physically moved. One of the dyes in this class is C.I. Vat Blue 20, which Wegmann tried to explain on the basis of his theory. The present result shows that Wegmann's theory does not apply in this case. The second group of dyes do not show a change in dichroism on soaping treatment. It is not certain whether these dyes have changed their orientation. It is also likely that the orientation may have changed during oxidation itself before soaping. This is supported by the fact that the dyes of the first class show pronounced change in visible absorption (large shade change) whereas dyes of the second class do not show appreciable change of shade. Some benzamido substituted vat dyes were also studied but these, because of freedom of motion of amido and phenyl groups, do not give definite conclusions.

As for the theory of completion of oxidation process, it is observed that the intensity of the carbonyl group does not change much on soaping in these dyes. However, when indigoid dyes were studied, it was observed that the intensity of the carbonyl band increased progressively on soaping. Thus, the progressive oxidation is only observed in indigoid dyes.

Advanced Centre in Applied Chemistry,
Dept. of Chemical Technology,
Matunga, Bombay-19, *March* 9, 1971.

M. L. GULRAJANI.
M. R. PADHYE.

---

1. Schöll, R., *Ber.*, 1911, **44**, 1448.
2. Sumner, Vickerstaff and Waters, *J. Soc. Dyers Colourists*, 1953, **69**, 181.
3. Wegmann, *Ibid.*, 1960, **76**, 282; *Am. Dyestuff Rept.*, 1962, **51**, 276.

STATUS OF SOIL FERTILITY IN THE RIVER NARMADA UPPER CATCHMENT AREA

IT is a general belief that the fertility of soil has got a profound bearing on the richness of the vegetation it supports. In our study on Ecology of River Narmada Upper Catchment Area, curiously enough, the problem arose whether the underlying soils (in terms of their fertility value) have got a definite bearing on the growth performance of forest vegetation.

The forest vegetation has been surveyed and classified into 11 forest associations, as described earlier (Pandeya, Pandya, Murthy and Kuruvilla, 1967). Soils underlying each association have been collected by profile method and were analysed for their physico-chemical characteristics. Total Relative Growth Index (RGI) on a certain topographic situation has been calculated by summing up the values of individual RGI of all the component species which denoted the richness of the forest growth of each association (or growth performance of all the species on a site). A Fertility Index (FI) has been formulated as follows:

$$\frac{\text{Clay} + \text{Silt}}{\text{Sand}} \times \frac{\text{Organic Carbon} \times \text{Total Nitrogen}}{\text{Sesqui Oxides}} \times \text{Calcium} \times \text{Sodium} \times \text{Potassium}$$

The index, though arbitrary, gives a very rough estimate of fertility of soil with respect to high base status, silty structure, porosity and consequently high water-holding capacity.

Total values of RGI of the 11 forest associations and values of the corresponding FI of the underlying soils are graphically presented in Fig. 1. From the figure, it appears that there does not exist any strict positive correlation between the two variables.

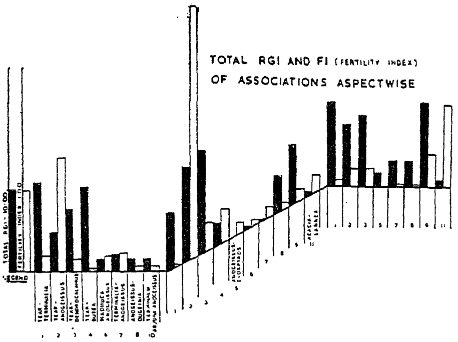


FIG. 1

To confirm this observation, Correlation Coefficient—r has been worked out between the two factors. The value of r worked out to 0·011. This confirmed thereby that fertility (in terms of base status) has no bearing on the growth of the forest vegetation, at least in the Upper Catchment Area of River Narmada. This supports the view expressed by Pandeya (1963) earlier, that soil is a function of its environment, properties of which are governed by a set of independent soil-forming factors, However, a good Climo-Vegetational relationship exists in this study area and will be detailed in the subsequent publications.

I am grateful to Professor S. C. Pandeya for guidance and encouragement. I am also thankful to the C.S.I.R. for the award of a Junior Fellowship. Thanks are also due to the officials of the Forest Department, Madhya Pradesh, for their help during the field survey.

Dept. of Biosciences, M. SREEDHARA MURTHY.
Saurashtra University,
Post Bag No. 9, Rajkot,
(Gujarat State), *March* 9, 1971.

---

1. Pandeya, S. C., "Soil-Vegetation relationships in Central India," *Proc. Nat. Acd. Sci.*, India. 1963, **33**, 63.
2. —, Pandya, S. M., Murthy, M. S. and Kuruvilla, K., "Forest Ecosystem : Classification of forest vegetation with special reference to the forests in the River Narmada Catchment Area," *J. Indian bot. Soc.*, 1967, **46** (4), 381.

A PEDIMENT SURVEY TO THE NORTH OF COIMBATORE IN SOUTH INDIA

PEDIMENT refers to the land surface adjacent to hill ranges where the bedrock is frequently exposed beneath a veneer of colluvium and alluvium. It is sometimes contended that the pediment portion is either the lowermost of hillslope elements or the uppermost of the elements of plainslope and characterises a zone essentially of transportation. Individual pediments coalesce to form a pediplain. Pediplanation is held as the process that is responsible for the landscape evolution at many places in the world and claimed by King[1] as worldwide in effectiveness irrespective of the variation in climate. Study of individual pediments and pediplains in quantitative terms will aid in our understanding of the processes involved in their formation and distribution.

A distinction has been made in the pediments recognised to the north of Coimbatore (Lat. 11° 0′ N; Long. 76° 59′ E) in Tamil Nadu of South India. The relatively narrow zone of land from the piedmont angle upto a point where it is covered by an appreciable thickness of alluvium is called a rocky pediment. Rocky pediment is characterised by frequently exposed fresh rock at shallow depths. The other segment or the rest of the pediment is called the alluviated pediment, which is characterised by greater overburden, and with kankar cap-pings and intercalations and by leaching of calcareous matter. This still is a part of a characteristic pediplain. Interpediment gullies naturally flow down the pediment and are moderately spaced around Coimbatore. The subtrellised pattern of drainage here is due to the attitude of the steeply dipping gneisses and schistose rocks of the Precambrians in an east-west direction. The drainage density, or the length of streams of all orders put together per square mile, comes to 5 + and this reflects the texture of the terrain.[2]

Topographic profiles on the rocky pediment from six localities selected at random, 10 to 15 miles NNW of Coimbatore (Toposheet 58 A/16), have been statistically analysed. The lithology of these areas varies from granitic to schistose in nature. The profiles were taken in a direction parallel to the line of the adjacent piedmont angle and moving north from their respective points of origin. This generally happens to cross the interpediment gullies. The inclinations of the pediment are noted with an abney level for every 50′ and the fractions rounded to the nearest quarter of a degree. In all, thirty readings of the ground inclination are so recorded (Table I).

TABLE I

	Concave (−ve)	Convex (+ve)	Total
No. of observations ..	17	12	30 (one horizontal)
Average of inclinations	2° 34′	2° 54′	2° 56′
Standard deviation ..	1° 23′	1° 35′	1° 28′

It follows from this study that the convexities and concavities are fairly equally distributed over the rocky pediment in a section parallel to the piedmont angle. The average angle at which the pediment undulates is 2½°. But this is likely to be affected by the spacing of the interpediment gullies or the texture of the terrain. The distance of the pediment surveyed from the backing hillface may also affect the amount of inclinations of the pediment. In the present case, the areas selected are from 250 yards to about 3,500 yards from the backing hill faces.

These observations have a bearing on the present concepts over the pediment evolution in different directions, particularly across the interpediment gullies. Normal to the interpediment gullies, the rocky pediment exhibits a multiconcave to rolling topography. The nature of topography, however, is dependent upon the drainage density. The wider the streams are spaced, the more planned is the rocky pediment. But the tendency appears to be towards a planar surface by the reduction of the land between successive interpediment gullies. Main pediment formation may be due to the retreat of scarp. But the reduction and planing of the pediment itself is effectively related to fluvial processes and mass-movement. This perhaps explains the observed absence of any significant relation between the length of a pediment, drainage area above a pediment and the lithology of the pediment area over the pediment angle.[3-5]

The financial assistance of the Council of Scientific and Industrial Research to one of the authors (Y. J. P.) is thankfully acknowledged.

Geology Dept., Y. J. PARDHASARADHI.
Andhra University, R. VAIDYANADHAN.
Waltair, *March* 4, 1971.

---

1. King, L. C., *The Morphocology of the Earth*, Oliver & Boyd, Edinburgh, 1962, p. 699.
2. Pardhasaradhi, Y. J., *Jour. Ind. Geos. Assoc.*, 1969, **10**, 97.
3. Tanner, W. F., *Trans. Amer. Geophy. Union*, 1956, **37**, 605.
4. Mammerickx, J., *Amer. Jour. Sci.*, 1964, **262**, 417.
5. Dury, G. H., Ongley, E. D. and Ongley, V. A., *Australian Jour. Sci.*, 1967, **30**, 33.

ON THE OCCURRENCE OF PLANT REMAINS IN THE PHYLLITES OF BHIKIASAIN AREA, ALMORA DISTRICT, UTTAR PRADESH

PHYLLITES, mica schists and quartzites occurring in the Bhikiasain area of Almora District, Uttar Pradesh, constitute a part of the Krol nappe system of the Lesser Himalaya. During the course of detailed study of these rocks, the writers noticed the presence of fragmentary plant remains. This discovery may be of considerable significance since the rocks of the Krol nappe system are considered to be unfossiliferous and their age is a matter of dispute.

Fresh phyllite chips were macerated in hydrofluoric acid taking all possible precautions against laboratory contamination. The residue, after washing with distilled water, was mounted in glycerine jelly. On examination under a microscope plant remains, of reddish-brown colour, were observed. These include :

(*i*) Tracheids with vestured bordered pits, round, 17 μ diameter; orifice elliptical, $6 \times 3\ \mu$, inclined; 4–5 pits in cross field (Fig. 1, A), (*ii*) Tracheids with simple bordered pits, round, $15\,\mu$ diameter; orifice elliptical, $10 \times 3\,\mu$, vertical; 2 pits in cross field (Fig. 1, B).

(*iii*) Cuticles with polygonal cells, $7\,\mu$ across, some of which are thickened (Fig. 1, C).

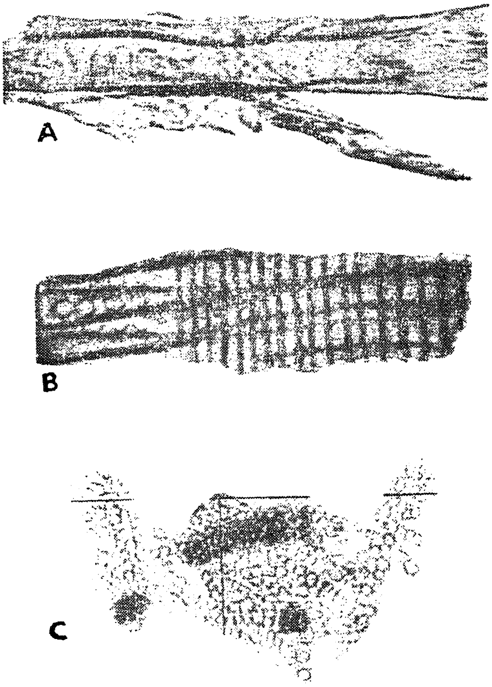


FIG. 1. A–C. Plant remains from phyllites of Bhikiasain area.

The general characters suggest that the remains are of gymnospermous wood.

On the basis of lithology and stratigraphic position, the rock units of Bhikiasain area can be correlated with Jausar[1] formation, the age of which is problematical. Auden[2] considers it to be Cambrian-Devonian. Gansser,[3] in his stratigraphical column, has placed the Jausars in the Ordovician while Boileau[4] considers them to be Precambrian to Lower Cambrian. Valdiya[5] correlates the Jausar and Nagthat formations with the Alwar and Bijawar formations of Peninsular India which are usually regarded to be of Precambrian age. In this context, the present discovery of plant remains is significant. Gymnosperms are generally considered to have evolved during the Upper Devonian. This suggests a younger age for the Jausars, i.e., Upper-or Post-Devonian. Detailed investigations, which are underway at the University of Poona, may throw further light on the subject.

The writers are indebted to Prof. B. G. Deshpande for his constant encouragement and for critically going through the paper. They are thankful to Shri A. V. Phadke for taking the photomicrographs. The senior author gratefully acknowledges the financial assistance received, for fieldwork, from the Wadia Institute of Himalayan Geology, Delhi.

Dept. of Geology, K. B. POWAR.
University of Poona, V. G. PHANSALKAR.
Poona-7, *March* 4, 1971.

---

1. Auden, J. B., *Rec. Geol. Surv. India*, 1936, **71**, **74**.
2. Director's report, *Ibid.*, 1949, **78**, **74**.
3. Gansser, A., *Geology of the Himalayas*, Interscience Publ., N.Y., 1964.
4. Directors's Report, *Rec. Geol. Surv. India*, 1954, **86**, 20.
5. Valdiya, K. S., *Report*, 22nd *Int. Geol Cong.*, *New Delhi*, 1964, Part 11, p. 15.

AN AMPHISTOME CERCARIA FROM *GYRAULUS EUPHRATICUS* (MOUSSON)

NATURAL infection with *Cercariae indicae* XXIX in this snail constitutes the only report of an amphistome cercaria under the "Pigmentata" group,[2] though experimental infection of *Gyraulus convexiusculus* with cercaria of *Gastrothylax crumenifer* has been reported.[4] Two other types, *Cercaria chungathi* and *C. gyraulusi*, from *G. convexiusculus* have also been described.[1]

Numerous specimens of *G. euphraticus* were collected during October, 1969, through December, 1969, from the ponds at Raya and Bhainsa about 13 kilometres from the college premises. These were individually kept under sunlight, between 9-12 a.m., in beakers half-filled with tap-water for observing the emergence of the cercariae harboured by them. Among the trematode larvae found to emerge, the amphistome cercariae were studied in slide preparations of the live specimens. One type of amphistome cercariae available represented the "pigmentata"[1] group. With an extremely low incidence, 12 specimens of larvae form were available for morphological study including the excretory system. The process of encystment was also observed. A brief account of cercaria and metacercaria has been attempted. Feeding experiment was not possible due to inadequate material.

The cercaria, 0·470 × 0·380 mm size and with 0·353 mm long tail, lacked pigmentation and had oral sucker of 0·029 mm diameter; 0·094 mm long oesophagus; short intestinal and $2{\cdot}4\,\mu$ breadth. The pathogen was identified the body ; acetabulum of 0·044 mm in diameter ; excretory bladder with anterior excretory pore and main excretory trunks, with a transverse commissure without any diverticulum and situated behind the intestinal bifurcation, draining into it posteriorly and, after reaching the anterior level, passing backwards to enter the acetabular area ; eye spots situated between the anterior end of the body and the level of intestinal bifurcation (Fig. 1).

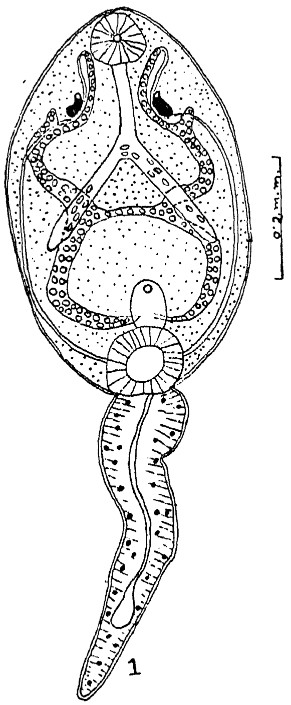
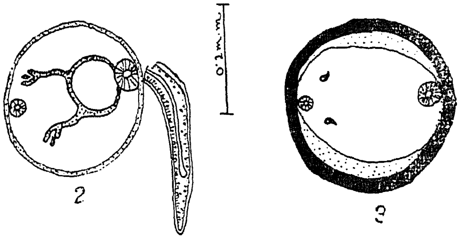


FIG. 1. A live specimen of the amphistome (pigmentata) cercaria from *G. euphraticus* showing the digestive and excretory system.

After a free-swimming life of 20-30 min, the process of encystment in this cercaria began with partial severance of the tail and in consequence of the deposition of the cystic material as a thin layer (Fig. 2). A complete separation of the tail was later achieved and a greater deposition of the cystic material produced. The metacercaria, of 0·292 × 0·318 mm in size, was smaller than the earlier form and had a 0·016 mm thick cyst-wall. The larva inside revealed the two suckers and the eye spots (Fig. 3). The pattern of the excretory system was, however, evident in the earlier stage (Fig. 2).

On account of absence of diverticulum in the transverse commissure, this cercaria resembles *Cercaria bulimusi*, stated to possess an oesophageal sphincter absent in the present form. *Cercariae indicae* XXXII,[3] according to Peter and Srivastava,[2] is smaller in size and has relatively large suckers, the oesophagus is nearly half long as the body and the shorter intestinal caeca do not reach three-quarter of the body length. An information about the genital rudiments could not be available on account of the limited material. The identity of this form exhibiting some affinities of these two cercariae would be possible on detailed study after feeding experiments with more material.



FIGS. 2–3. Fig. 2. Another cercaria under initial stages of encystment. Observe the typical excretory system, the beginning of the separation of the tail and a thinner cystic wall. Fig. 3. A full developed metacercaria.

Grateful acknowledgement is due to Dr. B. P. Pande, for his guidance, and to the Principal of the College, for the facilities provided.

Dept. of Parasitology, R. D. AGRAWAL.
U.P. College of Vet. Sci. and
Animal Husbandry,
Mathura, *February* 17, 1971.

---

1. Peter, C. T. and Srivastava, H. D., *Proc. Indian Sci. Cong.*, 42nd, 1955, **3**, 353.
2. —, —., *Indian J. Helminth.*, 1960, **12** (1), 51.
3. Sewell, R. B. S., *Indian J. Med. Res.*, (Suppl.), 1922, **10**, 1.
4. Tandon, R. S., *Zeitsch, fur Wissensch. Zool.*, 1957, **160**, 39.

THE GERMINATION OF TRUE SEEDS OF POTATO UNDER LONG STORAGE CONDITIONS

BESIDES being the basic material for breeding programmes, the true seeds of potato are of value in the following cases : (*a*) a large number of wild and cultivated collections can be maintained through true seeds and it is sufficient if these collections are grown once in a few years, (*b*) maintenance of germ plasm collections through true seeds eliminates all virus diseases, as no potato virus disease is seed-borne, and (c) distribution of materials of genetical and breeding value can be easier and quicker through true seeds as compared with the distribution of materials through seed tubers which are bulky and are subject to severe quarantine measures.[1] In these cases, it will be advantageous if seeds can be stored for many years without any loss in germination capacity. Under artificial conditions of storage, true seeds have been reported to retain good germination potentiality even for 15 to 20 years.[1]

In India, hybridisation work in the potato for genetical studies and for selection of types, under the different agroclimatic regions, is carried on in Kufri-Simla where most of the potato varieties and hybrids flower. The seeds of crosses made in the months of June-July are available during the months of September-October. These seeds are not normally utilised for growing of hybrid population in the regions where potato is a *rabi* (October-March) crop, as the true seeds have been observed to show varying periods of dormancy.[3] The seeds of crosses are, therefore, stored till the months of September-October of the following year. In these regions, particularly the Indo-Gangetic Plains, the seeds, during storage, pass through a cold season during which the room temperature in many places drops down to about 5-6° C in the months of December and January followed by an extremely hot season during which the room temperature rises to about 42-45° C during the months of May and June. In the present note, the results of a study on the germination of true seeds of potato stored under ordinary laboratory conditions for about 10 years, are reported.

Seeds collected from inbreds and some crosses in the months of August and September 1961, 1962 and 1969 were put in glass vials, corked and sealed with paraffin wax. The vials were placed in a tin container and kept in an iron almirah at room temperature till August 1970. Seeds were germinated during September 1970 after giving a pre-chilling treatment at 16-18° C for 12 days to dry seeds.[2] The data on germination of these seeds are given in Table I.

TABLE I

Germination of true seeds of potato

No.	Type of seed	No. of seeds kept for germination	No. of seeds germinated	Percentage germination	Mean for years
	A Seeds stored in 1961				
1	Phulwa (selfed)	340	285	83·82	
2	Kufri Kuber (selfed)	250	176	70·40	
3	Kufri Sinduri × Phulwa	180	106	58·89	
4	Up-to-date × Phulwa	210	155	73·81	71·73
	B Seeds stored in 1962				
5	Phulwa (selfed)	350	270	77·14	
6	Kufri Kuber (selfed)	260	195	75·00	
7	Kufri Kuber × Phulwa	405	345	85·19	
8	Up-to-date × Phulwa	360	285	79·17	79·12
	C Seeds stored in 1969				
9	Kufri Alankar (selfed)	120	88	73·33	
10	Kufri Jyoti (selfed)	90	64	71·10	72·22

The data obtained in the present study show that true seeds of potato stored for about 10 years have not shown any deterioration in their germination capacity as compared with that of the seeds stored during 1969. This compares favourably with the germination values obtained in seeds stored for one year in the different breeding investigations during the last 10 years, which was about 75% under optimum conditions.

I am indebted to Dr. Hari Kishore, Head of the Genetics Division, Central Potato Research Institute, Simla, for useful criticism, and to Dr. Mukhtar Singh, Director, for facilities.

Regional Res. Station, K. N. SUBRAMANYAM.
Central Potato Res. Inst.,
Jullundur, Punjab, *March* 13, 1971.

---

1. Howard, H. W., *Eur. Pot. Jour.*, 1969, 12 (4), 278.
2. Mehra, K. L., Subramanyam, K. N. and Gajaraja, C. P., *Ind. Pot. Jour.*, 1965, 7 (2), 106.
3. Srinivasachar, D. and Dwivedi, R. S., *Ibid.*, 1959, 1 (1), 10.

A NEW RECORD OF *CERCOSPORA* LEAF SPOT OF BAJRA (*PENNISETUM TYPHOIDES* STAPF.) IN INDIA

BAJRA is one of the major crops grown in southern districts of Tamil Nadu under rainfed and irrigated conditions. The crop is affected by a number of fungal and bacterial diseases. Among the fungal diseases, sugary disease, green ear and rust are the common diseases that occur and cause severe damage to the crop. In the present paper, a new leaf spot caused by *Cercospora fusimaculans* Atk. is reported for the first time in India.

The disease was noted on a hybrid variety, *viz.*, HB 3 at Pandavarmangalam and Edaiseval Villages of the Kovilpatti Taluk. It was also interesting to note that the disease has not affected the native cultivars which were grown by the side. The hybrid was raised under rainfed conditions during October 1970. The spots were noted on the standing crop in large numbers on the leaves and caused drying up of foliage. The spots were oval or round with dimensions of 5-10 mm length and 2-4 mm breadth. The spots were surrounded by dark brown margin with white to grey centre (Fig. 1). Similar type of spots were also seen on the leaf-sheath. Cross-section of the lesion revealed the following structures. The stroma is small, brown and fill the stomata; conidiophore subhyaline, sparingly septate, unbranched, geniculate measuring $2 \cdot 0$ to $3 \cdot 5\ \mu \times 10$ to $45\ \mu$; conidia cylindrical, hyaline, catenulate, slight to mildly curved, septa not visible clearly 4-5 septa, conidia usually measure $2 \cdot 4 \times 75 \cdot 07\ \mu$ with a range of $38 \cdot 4$ to $115 \cdot 2\ \mu$ length and $2 \cdot 4\ \mu$ breadth. The pathogen was identified as *Cercospora fusimaculans* Atk.[1]

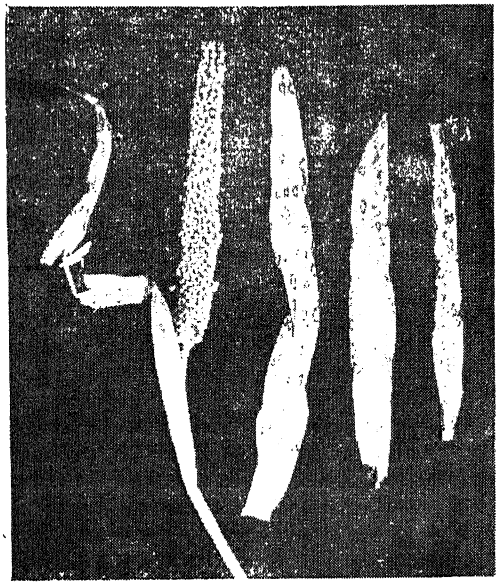


FIG. 1. Bajra leaves showing the symptoms of the disease.

Similar type of leaf-spot in bajra caused by *Cercospora fusimaculans* had been reported in Nyasaland.[2] The description of the pathogen and the symptoms produced by the pathogen are found to agree with the present leaf-spot disease in all respects except for very slight difference in spore measurements. The difference may be due to the influence of host and agroclimatic conditions of the country. The present fungus is, therefore, identified as *Cercospora fusimaculans* Atk. which is the first record of this fungus on bajra in India.

Our grateful thanks are due to Dr. K. Ramakrishnan, Dean and Additional Director of Agriculture, Agricultural College and Research Institute, Coimbatore-3, for his valuable suggestions in preparing this note.

Div. of Plant Path., M. N. ALAGIANAGALINGAM.
Regional Res. Stn., K. PILLAYARSAMY.
Kovilpatti; and C. S. KRISHNAMURTHY.
Agric. College and Res. Inst.,
Coimbatore-3, *February* 24, 1971.

---

1. Chupp, C., *A Monograph of the Fungus Genus* **Cercospora**, Ithaca, New York, 1953, p. 668.
2. Wiehe, P. O., *Mycol. Pap.*, 1953, **53**.

ON THE SWEETNESS OF WHOLE WHEAT MEAL

ONE of the factors contributing to the acceptability of wheat grains for *chapati*-making is the sweetness.[1] This has been attributed to initial sugar content by Austin.[2]

Reluctance on the part of consumers to accept recently introduced dwarf wheats[3] led us to examine the sugar content in the wheat grains and the factors contributing to the hydrolysis of starch resulting in the release of sugars.

For this study three tall wheats, *viz.*, C 591, C 273 and K 68 and three dwarf varieties, *viz.*, Sonora-64, *Lerma rojo* and *Sonalika* were selected. Grains were ground in Labconco Mill to pass through 40 mesh. Damaged starch was estimated by William's method.[4] Reducing, non-reducing, total sugars and diastatic activity were determined by A.O.A.C. methods.[5] Changes in whole meal dough with time were studied by wrapping the dough in a moist muslin cloth and keeping in an incubator at 32 ± 2° C.

Determination of sugars in the wheat grains revealed that total sugars were higher in the case of dwarf than tall wheats. Amount of total sugars in dwarfs varied from 379 to 392 when expressed as mg maltose/10 g whole meal. In tall varieties, the range was from 269 to 282. Higher total sugar content in dwarfs was due to high non-reducing sugar content. Values for reducing sugars were similar in tall and dwarf wheats (Table I).

TABLE I

Sugars (reducing, non-reducing and total), diastatic activity and damaged starch in whole meal of dwarf and tall wheat varieties

Variety	Reducing sugars (mg maltose/10 g whole meal)	Non-reducing sugars (mg sucrose/10 g whole meal)	Total sugars (mg maltose/10 g whole meal)	Damaged starch (absorbance, ×100)	Diastatic activity (mg maltose/10 g whole meal)
Sonora-64 ..	76	248	379	28	232
Lerma roja ..	56	266	379	16	160
Sonalika ..	60	270	392	20	190
C 273 ..	70	189	288	32	270
C 591 ..	50	192	272	24	282
K 68 ..	56	232	269	34	244

Since whole meal is kneaded into a dough prior to its utilization for preparation of *chapatties*, extent of starch damage and diastatic activity (mg maltose/10 g whole meal), which contributes towards formation of sugars, were determined. It is seen from Table I that varieties differ markedly in these characteristics. Tall wheats have high starch damage which varied from 24 to 34 (absorbance × 100) and diastatic activity from 244 to 270. In dwarfs, however, the values for starch damage and diastatic activity were lower.

Studies on formation of reducing sugars in whole wheat meal dough when kept at 32 ± 2° C showed that in variety *C 273*, there was an increase in reducing sugars (index of diastatic activity) from 59 to 244 in 5 hours. During the same period, enhancement of reducing sugars in the case of *Sonalika* was of the order of 42 mg/10 g whole meal only (*see* Fig. 1).

Diastatic activity in the whole wheat meal dough at 0, 3 and 5 hr showed that it was consistently higher in the case of variety *C 273*. At 0 hr it was 284 and increased to 342 at 5 hr stage. In the case of *Sonalika*, the value was 184 at 0 hr and increased to 222 at 5 hr (Table II).

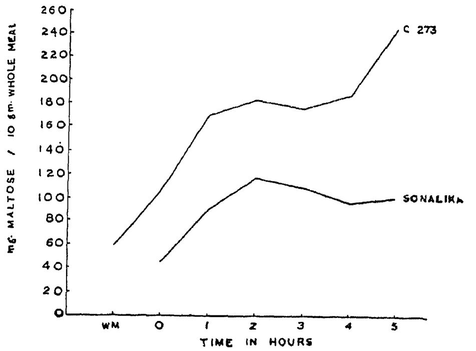


FIG. 1. Changes in the reducing sugars in the whole meal dough of C 273 and *Sonalika* WM-whole meal.

TABLE II

Diastatic activity (mg maltose/10 g whole wheat meal) in whole meal dough of C 273 and Sonalika *when kept at 32 ± 2° C*

Time (in hours)	Diastatic activity (mg maltose/10 g whole meal)	
	C 273	*Sonalika*
0	284	184
3	294	176
5	342	222

From the above studies, it is obvious that initial sugar content is different in wheat grains of tall and dwarf wheats. However, there is a change in the pattern with dough-keeping. It is likely that differences in the starch damage and the diastatic activity are the contributing factors.[6] It will be of interest to study the role of various wheat grain constituents, *viz.*, phytic acid, polyphenols on amylase activity as reported in the literature.[7,8] Irvine reported[9] that extent of starch damage is related to hardness/softness of the grains of wheat varieties. It may be of interest to view the above observations in light of the reported softness of dwarf wheats. Further, relative differences in sweetness of sugars[10,11] necessitate the identification of sugars in the milling fractions of wheat grains.

Thus the observations presented above suggest that it is not only the initial sugar content which is the determining factor but also the enzymatic changes which takes place in the dough.

The authors wish to thank Dr. H. K. Jain, for providing facilities and encouraging the present studies.

Cereal Quality Lab., Y. P. Abrol.
Division of Genetics, Vimal Mehdi.
Indian Agric. Res. Inst.,
New Delhi-12, *March* 19, 1971.

---

1. Austin, A., *Jour. Post-graduate School.*, 1966, **4**, 54.
2. —, *Indian Jour. Agron.*, 1964, **9**, 221.
3. Abrol, Y. P., *Proc. 5th World Congress on Cereals and Bread*, Dresden, Germany, 1970.
4. Williams, P. C. and Fegol, K. S. W., *Cereal Chem.*, 1969, **46**, 56.
5. A. O. A. C., *Official and Tentative Methods of Analysis*, 9th Edition, Washington, 1960.
6. Kent-Jones, D. W. and Amos, A. J., *Modern Cereal Chemistry*, Food Trade Press Ltd., London, 1967.
7. Cawley, R. W. and Mitchell, T. A., *Jour. Sci. Food and Agr.*, 1968, **19**, 106.
8. Milic, B., Stojanovic, S., Vucuevic, N. and Turcic, M., *Ibid.*, 1968, **19**, 108.
9. Irvine, G. N., *Abstract 5th World Congress on Cereals and Bread*, Dresden, Germany, 1970.
10. Lowe, Belle, *Experimental Cookery*, 4th Edition, John Wiley and Sons, N.Y. and London, 1961, p. 51.
11. Shellenberger, R. S., "Chemistry of Sweetness," *Symposium Proceedings on 'Frontiers in Food Research,'* Cornell University, Ithaca, N.Y., p. 45.

RADIATION-INDUCED PHOTO-INSENSITIVE MUTANTS IN COTTON

Although there are some reports of economically useful induced mutants in cotton,[1,2] the mutation breeding technique has not been very successfully exploited in this crop. This is perhaps partly due to the low frequency of induced mutations and also because most of the economically useful characters in cotton are governed by a very large number of genes. In spite of these limitations, the technique can be useful if employed with a specific purpose and efficient procedures are adopted to recover the mutants. Radiation-induced photo-insensitive mutants of great economic value are described in this note.

The cotton varieties at present under cultivation in Northern India are of the long-duration and medium staple type spinning around 40 S. Recently, cotton varieties with superior fibre quality have been developed and grown successfully under South Indian conditions. One such variety of *Gossypium hirsutum* is M.C.U. 5, with a staple length of 29–30 mm and a spinning value of 60–70 S. Though this variety covers an area of about two lakh hectares in Tamil Nadu, Andhra Pradesh, and Maharashtra, its cultivation cannot be extended to northern parts of the country because of its photosensitiveness. In north, it takes about 120 days to flower and when the temperature goes down in winter, the bolls fail to open.

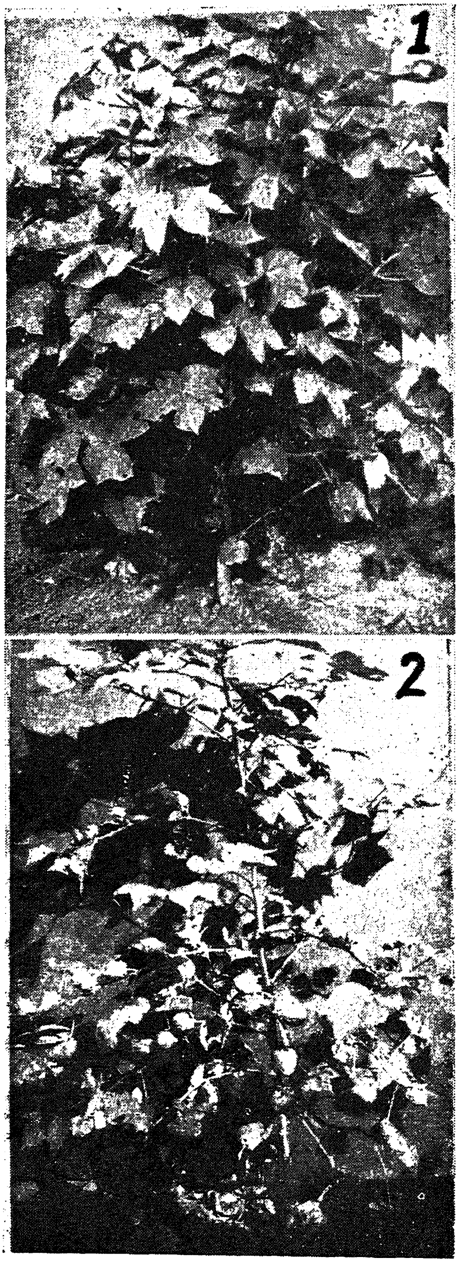
With the main purpose of inducing photo-insensitive mutations, dry seeds of M.C.U. 5 were irradiated with Co^{60} gamma-rays. Six lots of 250 seeds of each were given the doses of 5, 10, 20, 30, 40 and 50 Kr. The treatment produced varying degrees of lethality in the M_1 generation; the surviving plants were grown at Delhi along with untreated controls. The M_1 plants and the controls flowered in 115–120 days. M_2 progenies were raised at Delhi from the M_1 selfed plants.

Observations on the M_2 progenies led to the identification of early-maturing photo-insensitive mutant plants. These observations and others on the fibre characteristics are listed in Table I. In contrast to a monopodial, profusely branching and excessive vegetative growth habit of the controls, the mutants produced more of sympodial branches with large number of bolls and the plants were erect and more compact (Figs. 1 and 2). The mutants took 60–65 days to flower as against 118 days of the controls, thus they were earlier by about two months. The percentage of boll opening in case of controls varied from 0 to a maximum

Table *I*

Material	Dose of gamma-rays (Kr)	Days to flower	Boll opening (%)	Seed cotton yield (gm/plant)	Staple length (mm.)	Strength	Fineness	Maturity (%)	Ginning per cent
M.C.U. 5 (cont.)	0	118	14	30	29·5	9·0	130	63	34
Mutant 1 ..	5	60	80	130	29·7	9·1	149	76	33
,, 2 ..	20	60	74	132	29·5	8·7	150	77	31
,, 3 ..	20	65	63	90	28·4	8·3	126	72	32
,, 4 ..	20	65	60	156	29·0	8·3	115	67	29
,, 5 ..	20	65	63	112	29·2	9·1	141	76	30
,, 6 ..	30	65	100	65	28·7	8·8	143	74	37
,, 7 ..	40	60	64	95	28·7	8·7	130	71	30
,, 8 ..	50	61	70	135	28·2	8·5	125	73	32

of 14, but in mutants it varied from 60 to 100 when recorded after 175 days of sowing. This, in turn, increased the yield of seed cotton by 2 to 5 times. The other fibre qualities of length, strength and fineness were more or less similar to those of the controls. The ginning in one of the mutants (mutant 6) was increased to 37% as against 34% of control.



FIGS. 1-2. Fig. 1. Control. Fig. 2. Photo-insensitive mutant. Both plants 90 days old.

As regards efficiency of the radiation dose to induce photo-insensitive mutations 20 Kr of gamma-rays appeared most suitable. The higher doses induce more of seedling lethality and sterility; with lower doses, the frequency of mutants was considerably reduced.

Some of the mutants appear very promising and may be released for general cultivation in North Indian conditions in the near future.

Division of Genetics,
Indian Agric. Res. Inst.,
New Delhi-12, *March* 3, 1971.

R. N. RAUT.
H. K. JAIN.
R. S. PANWAR.

---

1. Afifi, A., Bary, A. A., Kamal, S. A. and Heikal, I., *Emp. Cott. Gr. Rev.*, 1966, **43**, 112.
2. Jagathesan, D., Swaminathan, M. S. and Puri, R., *Indian Cott. Gr. Rev.*, 1963, **17**, **96**.

MORPHOGENETIC VARIATIONS IN THE GAMETOPHYTE OF A 3X RACE OF A FERN - *HYPODEMATIUM CRENATUM* (FORSK.) KUHN

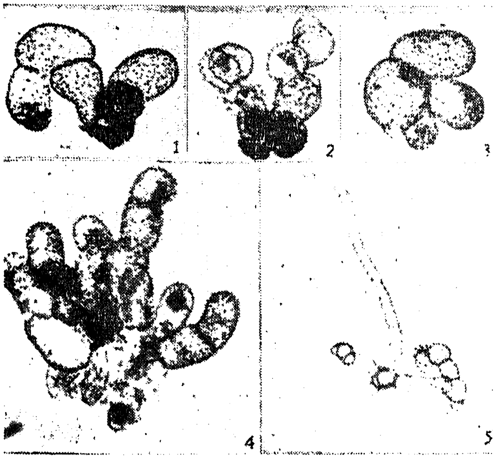
THE two morphologically dissimilar generations in the fern life-cycle, *viz.*, sporophyte and the gametophyte begin their development from a single-celled zygote and a spore. The gametophyte is a much too simpler organization than the sporophyte and its adult form is modulated through three growth sequences, *viz.*, mono-, bi- and three-dimensional. Experimental studies have shown that the early developmental stages in culture are light-dependent photoreactions reflecting differential gene activity.[3] However, no direct studies dealing with the effects of chromosomal and cytoplasmic disturbances inherent in the spores, on the above-mentioned growth sequences, have been made.

The Himalayan populations of this fern are comprised of 2 X ($2n = 82$), 3 X ($2n = 123$) and 4 X ($2n = 164$) plants. The 2 X and 4 X produce 32 spores per sporangium in contrast to 64 in majority of the sexual ferns. These spores, on germination, passed through the above-mentioned growth sequences leading to normal cordate prothalli. In 3 X plants, the meiotic aberrations resulted in highly unbalanced spores and germination trials in a sample gave upto 37% germination in contrast to 75–82% recorded for the X and 2 X spores. These data of 3 X are, however, expected to vary from sample to sample.

All the cultures were raised under uniform conditions of light and nutrition. The first germ-cell in 3 X failed to exhibit polarity gradient and, unlike the germ-cells in X and 2 X spores, retained potentiality to undergo mitosis more than once, the plane of spindle being different at each division. In many cases, the rhizoidal differentiation was either inhibited or considerably delayed.

Based upon such variations as: (*a*) plane of division in the first germ-cell, (*b*) its number of mitotic divisions, and (*c*) subsequent fate of the filamentous protonemata, the growth patterns may be described under the following three broad categories:

(1) In contrast to the highly asymmetrical plane of division in X and 2 X germ-cells, in 3 X, it may be oblique or vertical. The two almost equal-sized cells grow into two separate filaments and the differentiation of the rhizoidal cell is bypassed. As shown in Fig. 1, the cell on the left forms a filament of three cells, each cell exhibiting highly differential growth. In some cases, regular alternation of spindle axis was observed at each mitosis (Fig. 2).



FIGS. 1–5. Fig. 1. Ten-day-old protonema showing two divisions of the germ cell, the rhizoidal differentiation is inhibited, × 100. **Fig. 2.** Sixteen-day-old protonema developed as that of Fig. 1 or from a binucleate, abnormal spore, × 100. **Fig. 3.** Three successive divisions of the germ cell after the differentiation of the first rhizoid, the plane of division is different each time, × 125. **Fig 4.** Ditto, Twenty-day-old. rosette shaped protonema, × 125. **Fig. 5.** Fifteen-day-old protonema showing highly differential, monoplanar growth, × 100.

(2) The germ-cell may divide repeatedly in more than one plane, resulting in a rosette of filaments (Figs. 3, 4). A comparison of the protonema depicted in Fig. 5 with those in Figs. 3–4 show well-marked differences in cell and chloroplast size in different protonemata and also within the same protonema. The chromosomal analysis of the different types of protonemata demonstrated variable numbers from below the haploid level ($n = 41$) to well above the diploid level ($n = 82$). Thus, if the various patterns are evaluated in terms of the genotype, we can regard each viable spore as distinct.

(3) In one-month-old cultures, 32% protonemata did not grow beyond the filamentous stage and produced antheridia only. In other 35%, the filaments entered biplanar growth and formed cordate prothalli which bore archegonia. A detailed study on the sex organs and fertilization is in progress.

The results obtained simulate those produced by colchicine[2] and ionizing radiations[1] and to account for the disturbed growth sequences observed in the present material, the events at meiosis and the early developmental stages of the gametophyte may be envisaged as a continuum in the life-cycle.

Dept. of Botany,
Panjab University,
Chandigarh-14 (India),
March 17, 1971.

D. S. LOYAL.
PARMJIT PAIK.

---

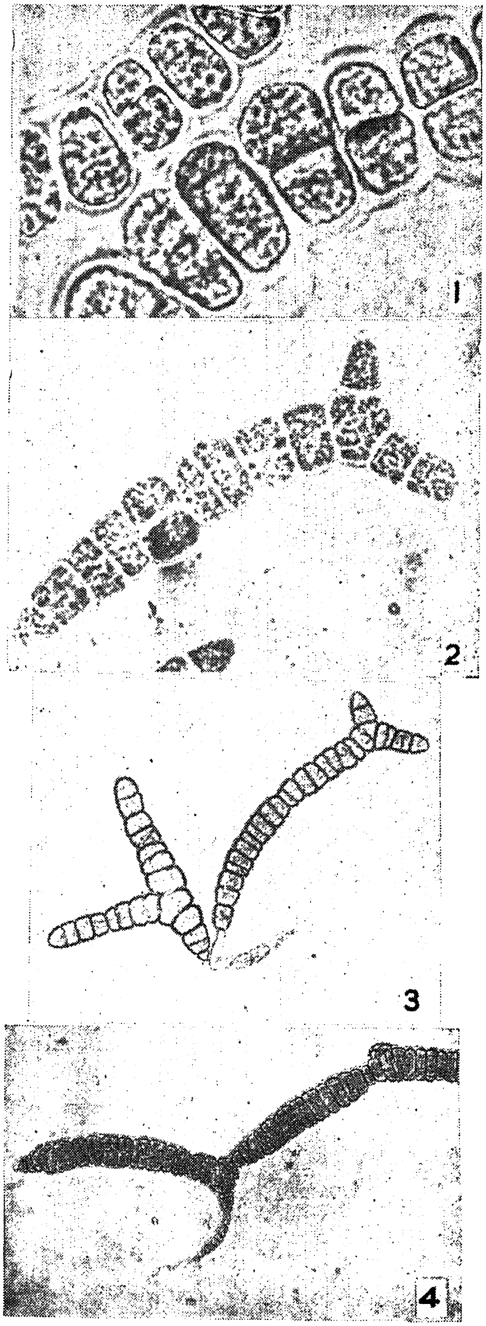
1. Kato, Y., *New Phytol.*, 1963, **63**, 21.
2. Mehra, P. N. and Loyal, D. S., *Ann. Bot.*, 1956, N.S. **20**, 544.
3. Mohr, H., "Photomorphogenesis," In *The Physiology of Plant Growth and Development*, Edited by M. B. Wilkins, McGraw-Hill Publ., 1969.

SOME CULTURAL OBSERVATIONS ON *SCHIZOMERIS LEIBLEINII* KUETZING

IN recent years, *Schizomeris leibleinii* Kuetz. has been studied in cultures by some workers. The studies show that the alga is highly variable in its morphological and cytological characters. Prasad and Srivastava (1963) have recorded the occurrence of zoospores as having 2–8 or more flagella and Patel (1967) has described a variable number of chromosomes as 15, 28 and 30, some cytological details and occurrence of thick-walled cysts. The species recently collected and cultured has yielded certain observations unrecorded so far.

The present form was growing attached to some decaying twigs of water plants in an open slow-flowing drain at Allahabad during November 1970. The alga readily produced zoospores when put in a liquid medium. It was reared in unialgal culture starting from such zoospores obtained from a single filament. It grows well in both liquid and solid

De's (1939) medium. Generally, after about three weeks' growth in a liquid or solid medium, the alga produces thin-walled resting cells or aplanospores with richly-accumulated food granules. They occur in uni-, bi- or multiseriate filaments and have a pale-green colour. Later, they become thick-walled (Fig. 1). At this stage, if the alga is transferred to a freshly-prepared solid agar medium (De's medium solidified with 1·5% agar), the cell-contents of the aplanospores are liberated by the rupture of the lateral wall and divide to form a few-celled (2–5) germlings which differ from those formed by the zoospores. In the latter case, germlings are typical unbranched short filaments, whereas the aplanospores on germination on solid agar plates, surprisingly produce processes giving an appearance of branched filaments. The processes formed in the apical cell present a look of typical dichotomy (Figs. 2 and 3) and by their further growth, result into a branched filament (Fig. 4). However, the processes, formed in an intercalary or in the basal cell, remain suppressed by the apical growth and give appearance of small outgrowths at later stage. These observations were repeatedly confirmed under identical cultural conditions. The inoculated agar plates were placed in an incubating chamber with an arrangement for continuous light (180 lux by a fluorescent tube and the temperature varying between 25° C and 30° C). The branches usually initiate till a few-celled growth of the germling but occasionally even in longer filaments. When the filaments with aplanospores are transferred to a liquid medium, there is profuse production of zoospores which germinate in the fashion recorded by earlier authors but rare occurrence of such branched germlings has been observed by us even in this condition.



FIGS. 1–4. *Schizomeris leibleinii* Kuetzing. Fig. 1. Filaments showing aplanospores, × 850. Figs. 2–3. Young branched filaments formed by the germination of aplanospores, × 750 and × 200 respectively. Fig 4. A mature branched filament, × 150.

It is interesting to note that in contrast to the present form of *Schizomeris*, Mitra (1947) recorded branching in *Uronema terrestre*, mostly in the germlings produced by the germination of zoospores and only occasionally from the apltnospores. But his record that the growth on solid medium coupled with weak illumination is conducive to the production of branching holds good also for the present form of *Schizomeris leibleinii*. Although occasional occurrence of branching in the germling stages is known in other genera of Ulotrichales like *Ulothrix* (Silva, 1953), *Uronema* (Mitra, 1947), the phenomenon is for the first time being recorded in the genus *Schizomeris*. Whether the occurrence of branching in these genera is significant with reference to the phylogeny of the group and throws light on the evolution of Chaetophorales or an expression of certain specialized conditions, remains an open question till enough data to support either view is available.

Deptt. of Botany, G. L. TIWARI.
Allahabad University, D. C. PANDEY.
Allahabad-2,
U.P., India, *March* 18, 1971.

---

1. De, P. K., *Proc. Roy. Soc. London.* B, 1939, **127,** 121.
2. Mitra, A. K., *Ann. Bot.*, 1947, **11,** 349.
3. Patel, R. J., *Phykos*, 1967, **6,** 87.
4. Prasad, B. N. and Srivastava, P. N., *Phycologia*, 1963, **2,** 148.
5. Silva, H., *Bull. Torrey bot. Cl.*, **80,** 342.

POST-HARVEST CHEMICAL TREATMENT OF APPLE FRUITS AGAINST ROT AND DETERIORATION

POST-HARVEST losses of apple fruits on account of infection by *Alternaria tenuis* have been reported by Grewal.[3] During studies on microbial deterioration of apple fruits in transit and storage in recent years, the authors frequently encountered this fungus causing rot and decay which gives the fruits an unsightly appearance rendering them practically unfit for sale and consumption. A perusal of literature revealed that no worthwhile attempt has been made in this country to find suitable control measures against this disease. Studies of Dharam Vir[1] and Dharam Vir *et al.*[2] have shown that intensity of losses on account of such type of diseases occurring during transit and storage can be substantially reduced by suitable treatments. Results of the evaluation of three chemicals as post-harvest dip treatment for the control of this disease are presented.

EXPERIMENTAL

Three chemicals, *i.e.*, calcium propionate, allisan and thioacetamid, were used in the investigations. Apple fruits (variety Ambari) in healthy and firm condition were selected and each fruit was given a small cut at four uniform places (Fig. 1). This was followed by inoculations which were done by spraying the spore suspension of *A. tenuis* prepared in sterilized water, on to the fruits with the help of an atomiser. After 12 hours of incubation, fruits were divided into four lots, three of which were treated with different chemicals while the fourth was kept as control. The treatment was done by dipping the fruits in water solution of each chemical prepared in sterilized water at 1,000 ppm, for a period of 2-3 min. Fruits kept as control were subjected to the same procedure except that no chemical solution was used and instead the fruits were dipped in sterilized water for the same period. Fifteen fruits were used for each treatment. The fruits were later dried, closely packed together in cardboard boxes and incubated at room temperature (21-24° C). The boxes were periodically opened and fruits in various treatments were examined for the initiation of rotting around the cuts. It was observed that while in the untreated fruits, rotting initiated around the cuts on the third day, the treatment of fruits with thioacetamid suppressed the development of symptoms up to 35 days. Fruits treated with calcium propionate and allisan developed rotting on the sixth and 10th day respectively. These investigations clearly bring out the efficacy of thioacetamid as a post-harvest dip treatment for prolonging the storage life of apple fruits against rot and decay caused by this disease. The use of thioacetamid does not present any health hazard problems.

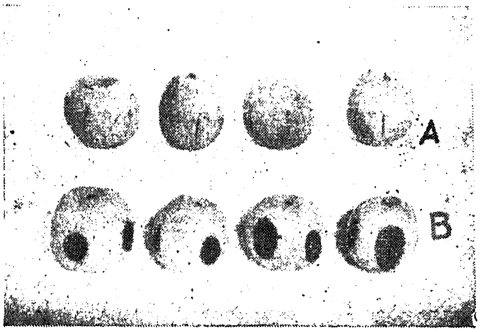


FIG. 1. Showing efficacy of thioacetamid for the control of apple rot. A and B represent respectively treated and untreated (control) fruits.

ACKNOWLEDGEMENTS

Sincere thanks are due to Dr. S. P. Raychaudhuri for his keen interest and encouragement during the course of these investigations.

Division of Mycology and DHARAM VIR.
Plant Pathology, ASHOK GAUR.
Indian Agric. Res. Inst.,
New Delhi, *February* 19, 1971.

---

1. Dharam Vir, *Abst. Second International Sym. Plant Pathology*, Indian Phytopath. Society, New Delhi, 1971, p. 99.
2. — Raychaudhuri, S. P. and Thirumalachar, M. J., *Hindustan Antibiot. Bull.*, 1968, **10,** 322.
3. Grewal, J. S., *D.Phil. Thesis*, Allahabad University, 1954.

EFFECTS OF GROWTH RETARDANTS ON FLOWERING AND APICAL DOMINANCE OF MANGO (*MANGIFERA INDICA* L.)

THERE is a strong apical dominance in mango. As long as an apical bud of shoot remains intact, there is little axillary growth either vegetative or reproductive. Axillary vegetative growth or flower may, however, appear, if the apical bud is damaged or removed, thus eliminating the effect of apical dominance.[4–7] The phenomenon of apical dominance is primarily based on endogenous growth regulator system.[1–3] Exogenous application of growth-regulating and flower-inducing chemicals are known to bring about some changes in this system which greatly reduce or eliminate apical dominance.[3] The present note deals with the results of an experiment on the effect of Cycocel and B-Nine on flowering and apical dominance of a biennial bearing mango cultivar *Langra.*

The experiment was conducted during 1969-70 employing 5-year-old clones of *Langra* mango. Cycocel and B-Nine were applied as foliar sprays with Tween-20 (0·1% solution) as wetting agent at a concentration of 5,000 ppm. Also a control with application of a mixture of water and Tween-20 was provided. For each treatment, seven replicated whole trees of comparable sizes were used. The trees were sprayed seven times at monthly intervals starting from May 1969. The effectiveness of Cycocel and B-Nine was determined by the percentage of treated shoots flowering and the number of panicles, developed per treated shoot in the following spring. The relevant data are presented in Table I.

TABLE I

Effect of growth-retardant sprays on flowering and apical dominance of young Langra *mango trees*

Treatment		Mean percentage of shoots flowering	Mean number of panicles per shoot
Control	..	3·57	1·67
Cycocel 5,000 ppm	..	91·77	3·54
B-Nine 5,000 ppm	..	6·43	1·63
L.S.D. at 5 per cent.	..	9·47	0·76
,, 1 ,,	..	12·99	1·07

The results indicate that both the chemicals showed flower-promoting effect on the *Langra* mango, but the magnitude of flower promotion was significant in case of Cycocel only. Cycocel not only increased the percentage of flowering shoots but also induced the axillary buds on the treated shoots to flower along with the apical buds (Fig. 1) and thereby significantly increased the average number of panicles per shoot as compared to control. This is considered to be due to partial loss in apical dominance brought about by the repeated sprays of Cycocel. B-Nine, however, did not show any axillary flower-inducing effect. These are in line with the observation of Luckwill (1968) in which he points out that Cycocel destroys or greatly reduces apical dominance in young apple trees, while B-Nine fails to do so.

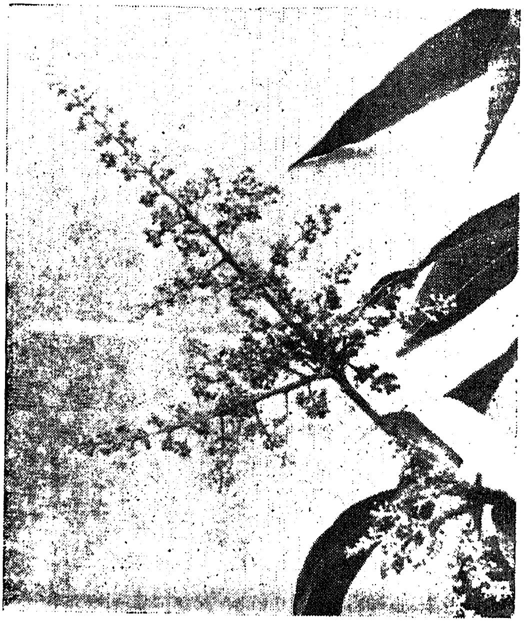


FIG. 1. Showing panicles developing from apicaland axillary buds on a Cycocel treated mango shoot.

Besides their fundamental importance, these results hold promise from the practical point of view of controlling flowering in mango by use of Cycocel.

The research has been financed by the U.S.D.A. under P.L. 480 Project.

College of Agric., S. C. MAITI.
Calcutta University, A. K. MUKHOPADHAYAY.
March 11, 1971. P. K. SEN.

---

1. Davies, C. R. and Wareing, P. F., *Planta.*, **1965**, **65**, 139.
2. Jacobs, W. P. and Case, D. B., *Science*, 1965, **148**, 1729
3. Luckwill. L. C., *J. Hort. Sci.*, 1968, **43**, 91.
4. Reece, P. C , Fur. J. R. and Cooper, W. C., *Am. J. Bot* , 1946 **33**, 209.
5. —. — and —, *Ibid* , 1949 **36**; 734.
6. Sen. P. K., Maiti, S. K. and Maiti, S. C.; *Internat'l. Sympcs. on Mango and Mango Culture Abst.*, 1969, p. 21.
7. Singh, L. B. and Singh, R. N., *Proc. Amer. Soc. Hort. Sci.*, 1956, **68**, 265.

REVIEWS AND NOTICES OF BOOKS

Advances in Corrosion Science and Technology (Vol. 1). Edited by M. G. Fontana and R. W. Staehle. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011, U.S.A.), 1970. Pp. x + 276. Price $ 22.50.

This is the first volume of a new series organised to provide a forum for review papers in the area of corrosions which will focus attention on those aspects of corrosion science and technology of current interest. The volumes of the series will be published nearly annually and each volume is expected to contain three to five review articles. Another aim of this series is to attract those in areas peripheral to the field of corrosion. Thus, physicists, physical chemists, and electronic scientists can make use of this forum for their contributions on corrosion problems.

The first volume contains the following articles: (1) Techniques for the Measurement of Electrode Processes at Temperature above 100° C by D. de G. Jones and H. G. Masterson, (2) Surface and Environment-Sensitive Mechanical Behaviour, by R. M. Latanision and A. R. C. Westwood; (3) Mechanism and Phenomenology of Organic Inhibitors, by G. Trabanelli and V. Carassiti; and (4) Anodic Oxidation of Aluminium, by S. Tajima.

A. S. G.

Raman Spectroscopy (Vol. 2). Edited by H. A. Szymanski. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. ix + 221. Price $ 17.50.

With the development of Laser as a practical source of high intensity monochromatic radiation, there has come in the last decade an unforeseen revival of interest in Raman Effect and its application by chemists to structural studies of molecules, and by physicists to testing in detail the various theories of scattering of light. Raman Spectroscopy, which, in essence, is the study of frequency change when light is scattered by molecules, has thus entered a new phase and advances in this field are indeed very rapid. To keep research workers abreast of current work in all aspects of Raman Spectroscopy, this continuing series on the subject has been envisaged.

The first volume was published in 1967 (for review, see *Curr. Sci.*, 1967, 36, 590). Since its publication, literature on the subject has grown large and the present volume attempts at bringing together the more important developments that have taken place both in theory and practice of Raman Spectroscopy.

The contents of the volume are: Chapter 1—Vibrational Rules of Selection and Polarization: Their Practical Uses and Limitations, by L. A. Woodward; Chapter 2—Developments in the Theories of Vibrational Raman Intensities, by J. Tang and A. C. Albrecht; Chapter 3—Raman Spectroscopy with Laser Excitation, by H. W. Schrotter; Chapter 4—Low-Frequency Raman Spectra of Liquids, by L. A. Blatz; Chapter 5—High and Low Temperature Raman Spectroscopy, by Ronald E. Hester; Chapter 6—Raman Spectroscopy with Poor Scatterers, by E. Steger; Appendix—Comments on the Derivation of the Dispersion Equation for Molecules, by G. P. Barnett and A. C. Albrecht.

Developments in Applied Spectroscopy (Vol. 8). Edited by E. L. Grove. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, 10011 N.Y.), 1970. Pp. ix + 325. Price $ 20.00.

Spectroscopy with its various branches of study, such as emission, atomic absorption, X-ray, nuclear particle, mass, Raman and Infrared, NMR and ESR, has become a growing field of applied research in physical, geophysical, chemical, biochemical, medicinal, and industrial laboratories. Computerisation, automation, and sophisticated built-in facilities in spectroscopic instruments are producing rapid changes in this field of applied spectroscopy.

The Chicago Section of the Society for Applied Spectroscopy in co-operation with other allied organizations has been sponsoring an Annual Mid-America Spectroscopy Symposia for the past two decades. Attendees and contributors to these Symposia come from all parts of the United States and Canada. The Proceedings of these Symposia are brought out annually since 1962 as *Developments in Applied Spectroscopy.*

The present volume is the eighth in this continuing series and it contains selected papers from the 20th Annual Mid-America Spectroscopy Symposium held in Chicago in May 12–15, 1969. The 28 papers in this volume include, besides papers on Emission Spectroscopy, X-ray Spectroscopy and Infrared Spectroscopy, the papers presented at the three special Symposia held during the session, namely, Symposium on Silicate Analysis, Symposium on Trace Element Analysis, and Symposium on Mossbauer Spectroscopy.

This collection of selected papers will prove an invaluable source for spectroscopists and analytical chemists. This continuing series as necessary additions to applied spectroscopy laboratories will assure spectroscopists and analysts keeping themselves abreast of the researches in this field. A. S. G.

Carnegie Institution of Washington—Year-Book 1969. (1530, P. Street, NW, Washington, D.C. 20005), 1970. Pp. x + 767. Price not given.

Year-Book 1969 of the Carnegie Institution of Washington, covering the period July 1, 1969, to June 30, 1970, contains President Caryl P. Haskins Report (the last one as he says, p. 27) and the detailed reports of the work in progress and results of special studies undertaken during the year, from the six departments of the Institution, namely, Hale Observatories, Geophysical Laboratory, Terrestrial Magnetism, Embryology, Plant Biology, and Genetics Research Unit. President Caryl P. Haskins in his address pleads for the necessity for an assured expansion of Federal support for science tied to the gross national product and welcomes the move to fix it at 0·1% GNP, as a beginning.

The name "Mount Wilson and Palomar Observatories" has been changed to *Hale Observatories* to honour George E. Hale, the Founder and first Director of the Mount Wilson Observatory and the man who inspired and planned the building of the 200″ telescope. Important progress made during the year in Sandage's program of improving "Hubbles' constant", and in Schmidt's program on space distribution and luminosity function of quasi-stellar objects is reported.

The Geophysical Laboratory was among the organizations which received lunar rock samples from the successful Apollo missions. Results of investigations of lunar and related materials reported in this Year-Book provide exciting knowledge in this newly-created field.

Progress made in diverse fields of study such as astrophysics, geophysics, seismology and biophysics is reported from the Department of Terrestrial Magnetism. Significant new findings in the continuing studies on the isolation, characterisation and control of genes in development are reported from the Department of Embryology.

The Department of Plant Biology reports the year's work done under the two major branches, physiological ecology, and biochemical investigations. The former chiefly concerned with investigations whose objective is to understand the functional basis of speciation and adaptation in plants, reports conclusion of two studies that have been in progress, namely, ecotypic investigations in *Mimulus* and in *Solanum dulcamara*. From the biochemical group, further work on chlorophyll complexes leading to new concepts of four forms of chlorophyll is presented. The Genetics Research Unit reports work on the persistent heterozygotes in Phage T 4.

A. S. G.

Books Received

Perspectives in Powder Metallurgy—Fundamentals, Methods and Applications (Vol. 4). *Friction and Antifriction Materials.* Edited by H. H. Hausner, P. K. Johnson and K. H. Roll. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011.) Pp. xvi + 334.

Computer Programming and Languages. By K. N. Dodd. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1969. Pp. viii + 137. Price $ 4.95.

Cryogenics and Refrigeration—A Bibliographical Guide (2). By Ellen M. Codlin. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1971. Pp. xx + 263. Price $ 29.50.

Dynamic Analysis of Ocean Structures. By B. J. Muga and J. F. Wilson. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xii + 377. Price $ 15.00.

Electrification Phenomena in Rocks. By E. I. Parkhomenko. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1971. Pp. xi + 285. Price $ 25.00.

Computational Methods in Band Theory. Edited by P. M. Marcus, J. F. Janak and A. R. Williams. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1971. Pp. xvi + 578. Price $ 25.00.

2912–71. **Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, L.P.T., Superintendent, at The Bangalore Press, Bangalore-18.**

OUTLOOK FOR HYBRID RICE IN INDIA

M. S. SWAMINATHAN, E. A. SIDDIQ AND S. D. SHARMA
Indian Agricultural Research Institute, New Delhi

ABSTRACT

Experience gained through commercial exploitation of hybrid vigour in maize, *Sorghum* and pearl millet indicates that heterosis not only results in substantial yield increases but also in stability of performance, particularly under environmental stress. Since there is further scope to exploit the full potentiality of high yielding dwarf varieties under irrigated conditions, commercial hybrids of rice, if developed, may first enable improvement and stabilisation of production levels of upland rices which form a substantial proportion of the total area under this crop.

In the light of the available information the prospects for the development of commercial rice hybrids are examined. While the dominant genes which have been reported to confer resistance to major rice diseases are a distinct advantage, care should be exercised in the choice of male and female parents to maintain the desirable grain quality of the F_1 hybrid. The possibilities of developing a commercial rice hybrid using the cytoplasmic source from the West African rice variety Sakotira-55 and the restorer systems from varieties like Basmati 370 are discussed to provide a hypothetical model in such work. Reference has also been made to the availability of ancillary characters in the rice germ plasm, which would aid development of commercial hybrids.

INTRODUCTION

THE widespread commercial exploitation of hybrid vigour in India is presently confined to *Zea mays* L., *Sorghum bicolor* (L.) Moench and *Pennisetum typhoides* Stapf *ex* Hubbard. The principal components of our experience with these crops can be summed up as follows: First, heterosis offers scope for making a large jump in yield level. Secondly, hybrid vigour confers a considerable degree of resilience to fluctuations in environment probably through early seedling vigour and has thus proved to be an advantage under dry-farming conditions. For example, hybrid *Sorghum* CSH-1 and hybrid pearl millet, H.B. 1, H.B. 2, H.B. 3 and H.B. 4 have yielded consistently more than the local varieties during seasons characterised by drought and aberrant weather. Thirdly, through an appropriate reconstruction of plant morphology and developmental rhythm and by exploiting additive gene action through suitable population improvement programmes, composites or varieties with as good a yield potential as the hybrids can be developed. Examples of this type are furnished by the Swarna variety of *Sorghum* and the composites of maize, *viz.*, Jawahar, Kisan, Vikram, Ambar and Vijay.[1,2] Fourthly, dependence on a single source of male sterility is fraught with danger if the male sterile parent carries dominant genes for susceptibility to important diseases, *e.g.*, susceptibility to ergot, downy mildew and grain smut in the case of CMS 23 A of *Pennisetum typhoides* or poor grain quality in the case of MS Kafir-60 of grain *Sorghum* which has a chalky endosperm.

SCOPE AND NEED FOR HYBRID RICE

Different estimates have revealed that a 25% gain in yield over the best commercial variety will be necessary for making exploitation of hybrid vigour in a self-pollinated plant an economically viable proposition. Several crosses reveal that this degree of enhanced yield can be attained (Table I). If in rice, hybrid vigour will confer the same degree of buffering against the vagaries of the weather as has been observed in *Sorghum*,[3] research on hybrid rice may certainly be worthwhile in India since out of the 35 million hectares under rice, over 20 million hectares are purely rain-fed. On the other hand, in the irrigated and abundant rainfall regions of India the full yield potential of the dwarf varieties is yet to be realised due to inadequacies in water management, agronomic and pest control practices and post-harvest technology. Therefore, even if the yield ceiling can be raised through hybrid rice, it may not be of immediate practical value in such areas. However, if stability in production can be achieved in upland rice, this will be a great contribution to preventing violent fluctuations in foodgrain production in India.

ADVANTAGES AND DISADVANTAGES OF THE RICE PLANT FOR EXPLOITING HETEROSIS

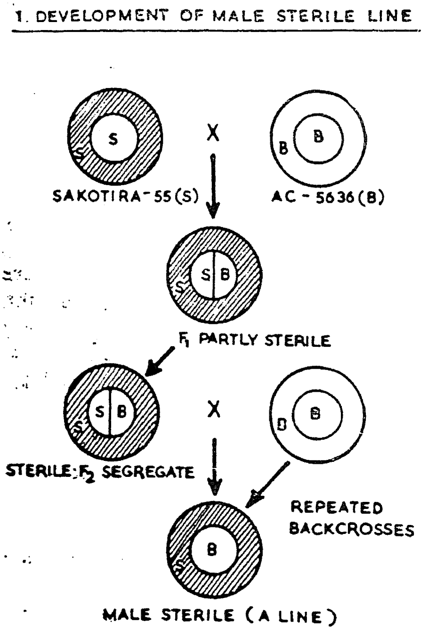
The possibility of ratooning and vegetative propagation[4,5] would make hybrid seed production much less expensive in rice than in crops like wheat. Secondly, dominant genes for resistance to diseases and pests like blast and gall midge are known.[6-8] Thirdly, other desirable characters such as early flowering,[9]

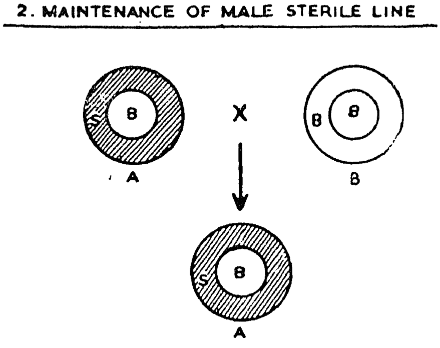
TABLE I

Manifestation of heterosis in some intervarietal crosses in indica rice

Cross $P_1 \times P_2$	Height (cm)			Panicle length (cm)			Tillers per plant			Grains per panicle			1000 grain weight		
	P_1	P_2	F_1	P_1	P_2	F_1	P_1	P_2	F_1	P_1	P_2	F_1	P_1	P_2	F_1
DGWG × RS II ..	91·5	128·0	135·8	24·7	26·4	31·5	7	5	14	119	239	277	24·00	24·00	26·50
IARI 5901 × RS II ..	85·5	128·0	136·0	21·7	26·4	28·9	7	5	10	138	239	196	24·50	24·00	27·00
IARI 10560 × RS II ..	100·6	128·0	138·8	23·8	26·4	31·1	7	5	8	133	239	277	22·00	24·00	25·00
IARI 10561 × RS II ..	100·6	128·0	145·3	24·2	26·4	30·7	7	5	8	135	239	329	22·00	24·00	23·50
DGWG × NP 130 ..	94·5	137·6	116·6	24·7	27·5	25·9	7	4	15	119	135	169	24·00	18·50	22·50
IARI 5901–2 × NP 130	90·6	137·6	127·0	25·8	27·5	27·6	8	4	12	172	135	189	22·00	18·50	21·50
IARI 5980 × NP 130 ..	88·5	137·6	125·0	26·7	27·5	24·0	5	4	18	146	135	139	21·50	18·50	20·50
IARI 599 × NP 130 ..	82·4	137·6	108·0	19·0	27·5	19·2	5	4	10	105	135	92	26·00	18·50	23·00
IARI 10560 × NP 130	100·6	137·6	111·0	23·8	27·5	26·1	7	4	13	133	135	222	22·00	18·50	21·00
IR 8 × RS 1 ..	95·6	126·0	136·5	28·5	27·5	26·1	8	5	36	175	237	290	28·00	24·00	26·60
IR 127 × RS 1 ..	130·00	126·0	163·6	29·0	27·5	28·4	4	5	48	375	237	290	20·00	24·00	18·25
S. 55 × Basmati 370 ..	80·00	151·0	160·6	20·5	29·5	29·6	6	4	46	106	135	215	25·00	19·50	23·55
S. 55 × AC 5636 ..	80·00	135·0	189·0	20·5	28·0	32·2	6	5	55	106	137	329	25·00	20·50	23·75
IR 127 × Basmati 370 ..	130·0	151·0	168·7	29·0	29·5	29·2	4	4	35	375	135	265	20·00	19·50	21·00

seed dormancy[10,11] and dense panicle[12] have been reported as dominant and hence can be incorporated in the hybrid rice without difficulty. Quality considerations influence heavily the price of rice in Indian markets. The F_2


1. DEVELOPMENT OF MALE STERILE LINE
S
S
X
B
B
SAKOTIRA-55(S)
AC-5636(B)
S
S
B
F1 PARTLY STERILE
S
S
B
X
B
B
STERILE F2 SEGREGATE
REPEATED BACKCROSSES
S
B
MALE STERILE (A LINE)


2. MAINTENANCE OF MALE STERILE LINE
S
B
X
B
B
A
B
S
B
A

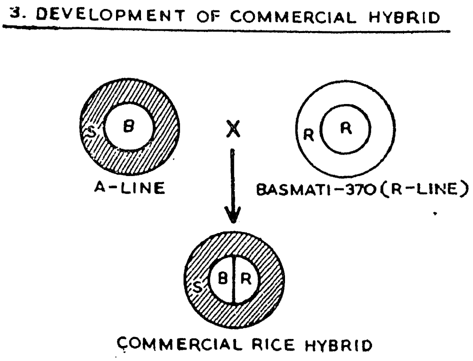

3. DEVELOPMENT OF COMMERCIAL HYBRID
S
B
X
R
R
A-LINE
BASMATI-370 (R-LINE)
S
B
R
COMMERCIAL RICE HYBRID

FIG. 1

Note : 1. In case restoration is easily obtained as in the case of *Sorghum* and diverse restorers are available, simultaneous testing for fertility restoration and agronomic desirability can be undertaken.

2. On the other hand if fertility restoration presents difficulties as in case of wheat, development of suitable restorer lines would be an additional step.

grains may show much variability in amylose content and gelatinization temperature and thereby affect the milling and cooking qualities. Hybrid rice may face an adverse price discrimination unless both the parents are carefully chosen so as to yield a quality hybrid.

PROSPECTS FOR DEVELOPING COMMERCIAL HYBRIDS

Given the necessary extent of manifestation of hybrid vigour, the major prerequisites for capitalising on such vigour commercially are: (*a*) a usable form of male sterility, and (*b*) floral characters such as long period of glume opening, protruding stigma, a long period of stigma receptivity, abundant production of pollen and availability of dominant genes for amylose content, gelatinization temperature and resistance to the major pests and diseases. No systematic research programme has so far been undertaken in India to explore the prospects for developing hybrid rice for commercial cultivation. Some of the observations relevant to the initiation of such a programme are summarised below:

Usable Form of Male Sterility.—Sporadic reports of the incidence of male sterility in rice exist beginning from an early record by Ramanujam.[13] Self-sterility has been recorded in *O. barthii* Cheval.[14] The genetic mechanisms underlying such self-sterility are yet to be elucidated. No case of cytoplasmic male sterility and fertility restorer genes has so far been recorded in India.

Recently, different degrees of fertility and sterility have been found at the Indian Agricultural Research Institute in different crosses involving a rice variety from West Africa, Sakotira-55 (*O. sativa*). Some F_1s (*e.g.*, Sakotira-55 × AC 5636) showed over 70% sterility. The reciprocal crosses showed differential fertility. A study on the lines indicated in Fig. 1 has been undertaken to examine whether the sterility arises from any specific interaction between Sakotira cytoplasm and gene(s) of the pollen parent. Environmental stability in the expression of male sterility is another important trait which will be tested. No work has so far been done on the chemical induction of male sterility.

Availability of Other Desirable Genes.—In the Assam rice collections maintained at the Indian Agricultural Research Institute, sufficient variation has been observed for the size of anther and stigma as well as for the duration of glume opening. The large feathery stigma protruding out of spikelet even after anthesis, large anthers bearing abundant pollen and longer period of glume opening are some of the mechanisms favouring cross-pollination. These could be exploited profitably.

CONCLUSION

It is premature to express definite views on the outlook for hybrid rice in India. Practically, no scientific effort has been expended so far in this field excepting the recording of a few useful traits as indicated in this paper. In the opinion of the authors, hybrid rice will have value in increasing yield and stabilizing production in upland areas provided the response of hybrid rice to fluctuations in rainfall pattern is similar to that observed in *Sorghum* and pearl millet. Before much further work on hybrid rice is done, it is proposed to gather data on the behaviour of several F_1 hybrids under upland conditions.

---

1. Rao, N. G. P., Venkataraman, R., Tripathy, D. P., Rana, V. K. S. and Sachar, J. S., *Indian J. Genet.*, 1969, **29**, **79**.
2. Swaminathan, M. S., Dhawan, N. L., Murthy, B. R. and Rao, N. G. P., *I.C.A.R. Year-Book*, **1970**, p. 33.
3. Rao, N. G. P. and Harinarayana, G., *Curr. Sci.*, 1969, **38**, 97.
4. Nair, N. R. and Sahadevan, P. C., *Ibid.*, **1969**, **30**, 474.
5. Richharia, R. H., *Nature*, 1962, **194**, 598.
6. Ramiah, K. and Ramaswamy, K., *Proc. Indian Acad. Sci.*, 1936, **3 B** 450.
7. Venkataswamy, T., *Diss. Abs.*, **1963**, **24**, **453**.
8. Shastry, S. V. S. and Seshu, D. V., *Paper Presented at IRRI Conference, Los Banos*, Philippines, April, 1971, p. 19.
9. Sampath, S. and Seshu, D. V., *Indian J. Genet.*, 1961, **21**, 38.
10. Shanmugasundaram, A., *Madras Agric. J.*, **1953**, **40**, **477**.
11. Narayanan Namboodiri, K. M. and Ponnaiya, B. W. X., *Agri. Res. J. Kerala*. **1963**, **8**, 30.
12. Anon, *U.S. Dept. Agr. Res*, 1963, Ser. ARS **34**, 28, **1**.
13. Ramanujam, S., *Madras Agric. J.*, 1935, **23**, **190**.
14. Jachuck, P. G. and Sampath, S., *Oryza*, 1966, **3**, (1), 49.

EFFECT OF FUNGICIDE DEXON (*P*-DIMETHYLAMINOBENZENEDIAZO SODIUM SULFONATE) ON SOIL AGGREGATION

N. G. K. KARANTH AND V. N. VASANTHARAJAN

Microbiology and Pharmacology Laboratory, Indian Institute of Science, Bangalore-12

ABSTRACT

Dexon (*p*-dimethylaminobenzenediazo sodium sulfonate), a soil fungicide, was found to lower the water stable aggregates when added to soil and incubated for a long time. With its disappearance, the soil structure seems to restore itself. The restoration is mainly brought by an increase in the 0·25 mm aggregates. The immediate effect of addition of the fungicides was an enhancement in the water-stable aggregates of the soil. Within eight weeks as much as 80–90% of the fungicide gets degraded in soil.

CONTROL of soil-borne plant pathogens particularly those affecting seedlings is essential for successful agriculture. This is achieved either by seed treatment with fungicides or applying them directly to soil. At the same time, it is increasingly being realised that large scale application of fungicides to the land brings along with it problems affecting the environment. Apart from this, the immediate effects of these additions on soil as an ecosystem have not been fully investigated. The fungicides may affect directly or indirectly both the microbial balance and the physical properties of the soil.

The Governments of various countries are directing now their serious attention towards testing thoroughly the effect of fungicides on other microbes, ascertaining at the same time, their stability, persistence, and movement in soil before recommending them for general agricultural use.

Among the seedling diseases, the more serious and deadly are the "damping-off" diseases caused by the phythiaceous fungi. No effective remedy was available against them until a few years ago. The fungicide Dexon (p-dimethylaminobenzenediazo sodium sulfonate), introduced recently, was observed to be rather specific against these organisms, most other fungi remaining unaffected by it.[1-4] We have been studying for the past few years the activity of Dexon and its degradation by micro-organisms in soil. In this communication we present our observations on the effect Dexon has on the soil structure.

MATERIALS AND METHODS

400 g of air-dried red-loam soil passed through 2 mm sieve were transferred to 400 ml polythene beakers. Dexon was incorporated at three levels, *viz.*, 0, 1,000 and 2,000 ppm and 0·1% nitrogen in the form of either ammonium chloride or sodium nitrite, these being the forms usually used in experiments to study nitrification. The contents were thoroughly mixed and incubated at room temperature (25-30° C). Three replicates were kept in each treatment. The moisture level was maintained at 60% of water holding capacity (WHC) of the soil by adding tap water periodically. The rate of nitrification of these two were followed but the results will be published elsewhere. For aggregate analysis, soil samples were drawn at monthly intervals. 10 g of wet samples from each treatment, in duplicate, were kept under 1 : 3 water for overnight and were then sieved through a nest of sieves manually. The aggregates retained on each sieve were then transferred into a weighed petri-dish, dried in the oven and their dry weights were recorded. The actual amount of aggregated material was obtained after subtracting the weights of primary particles. After drawing undisturbed samples for aggregate analysis, the contents were thoroughly mixed and samples were taken for the estimation of residual Dexon. The analytical techniques used for Dexon estimation was that of Anderson and Adams[5] with some slight modifications to suit the present experimental set up.

RESULTS AND DISCUSSION

Dexon recovered from soil at different time intervals is given in Table I. Only about 70-80% could be recovered immediately after application. The fungicide which is anionic can be sorbed by the organic matter in soil[6] and this may explain its low recovery. A part of it might also get adsorbed by the clay particles, mostly in the edges by iron and aluminium hydroxides. Dexon was observed to disappear rather rapidly in soil. Only about 7-20% could be recovered after 8 weeks. The rate of disappearance appears to be much faster than that reported by Alconero and Hagedorn[1] which might be due to the differences in the type of soil, temperature of incubation (25-30° C) and optimum conditions maintained throughout the experiments.

TABLE I

Residual Dexon in soil

Treatment	% recovery after		
	2 hours	5 weeks	8 weeks
1,000 ppm Dexon:			
No nitrogenous chemical ..	80·0	39·9	10·8
Ammonium chloride ..	79·0	62·6	16·1
Sodium nitrite ..	81·0	51·5	15·1
2,000 ppm Dexon:			
No nitrogenous chemical ..	71·0	30·8	7·6
Ammonium chloride ..	70·8	40·9	9·5
Sodium nitrite ..	81·4	49·9	20·8

Of interest was the finding that amending the soil with nitrogenous chemicals resulted in a slight increase in the residue levels. The availability of an easily utilisable source of nitrogen might spare the use of the fungicide as a nitrogen source. Further, those organisms that are capable of degrading the fungicide might slightly be suppressed by the faster proliferation of other saprophytes in the presence of a rich available nitrogen.

The effect of the fungicide on soil structure was even more profound. Within a few weeks of its application, a conspicuous fall in the total water stable aggregates occurred which was followed within a month by the tendency to increase and to reach the original levels. No doubt, the microbial activity so essential for aggregate formation might get inhibited by high concentrations of Dexon but it is more than likely that with the steady degradation of the fungicide the activity is regained, thereby enhancing the aggregate formation (Table II and Fig. 1). The recovery in the soil structure is mainly brought about by an increase in the 0·25 mm sized aggregates, which is the fraction that is considered to be of significance in evaluating soil structure in relation to agriculture.[7]

TABLE II

Effect of Dexon on aggregate status of soil

Treatment	Dexon ppm		
	0	1,000	2,000
Nil ..	38·2; 36·9*	20·8; 33·3	28·7; 36·6
Ammonium chloride	25·5; 25·8	20·8; 28·1	20·0; 31·9
Sodium nitrite	4·9; 3·4	3·1; 6·6	8·3; 5·5

* Per cent water stable-aggregates >0·125 mm after 5 and 8 weeks respectively.

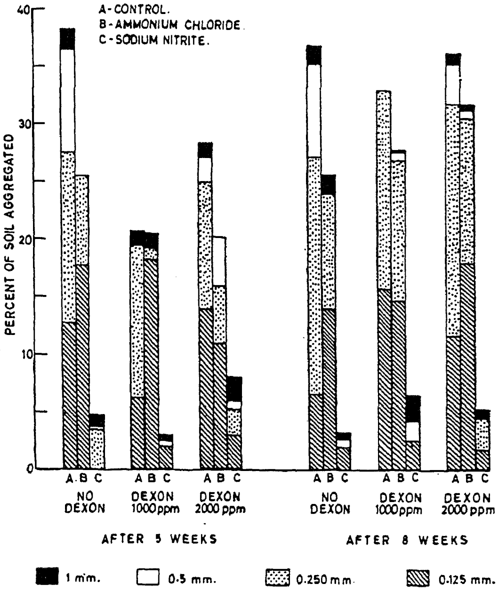


FIG 1. Distribution of water stable aggregates in soil treated with different levels of dexon and nitrogenous chemicals

The addition of the nitrogenous chemicals into the soil in the absence of a corresponding amount of carbonaceous material upsets the carbon nitrogen ratio, causing thereby a disturbance in the microbial balance. This could be one of the reasons for the fall in the amount of the aggregated material in all the samples treated with nitrogenous compounds. While this damage is not appreciable in the case of ammonium chloride, sodium nitrite has a devastating effect on the soil structure which may be due to its action on soil humic substances. The deleterious effect of high concentrations of sodium ions on soil structure is also well known.[8,9] When both fungicide and the chemicals are present we find a cumulative effect.

Since Dexon is frequently used as a seed dressing or as a soil drench prior to sowing, we considered it worthwhile to see whether or not it has any short time effect on soil structure. To verify this, 10 g of soil (< 2·00 mm) were transferred to paper cups; Dexon, ammonium chloride or sodium nitrite were added to the soil in the paper cups. The addition of the fungicide and the nitrogenous compounds were done in different sequences. After mixing them with the soil thoroughly, moisture level was brought upto 60% WHC. The control samples received only water. Half the number of samples were seived through immediately, whereas the other half was allowed to dry at room temperature before sieving. The results are presented in Table III.

TABLE III
Immediate effect of Dexon on soil aggregation

Treatment	% water-stable aggregate >0·125 mm	
	Sieved immediately	Sieved after drying
Control	8·5	14·3
Ammonium chloride without Dexon	10·3	12·2
Dexon and ammonium chloride added simultaneously	13·3	15·5
Dexon before ammonium chloride	15·5	8·9
Dexon after ammonium chloride	19·6	10·9
Sodium nitrite without Dexon	9·1	9·9
Dexon and sodium nitrite added simultaneously	19·3	11·9
Dexon before sodium nitrite	17·9	9·2
Dexon after sodium nitrite	21·0	9·2
Dexon only	14·9	17·8

On immediate sieving, all Dexon-treated soils showed greater aggregation than the untreated ones. Considerable portion of the increase came in fractions larger than 2·0 mm, a fraction which was altogether absent in soils wherein no Dexon was present. On immediate wet sieving, highest level of aggregation was witnessed in samples wherein Dexon was added at the end, whereas simultaneous addition of Dexon and the nitrogenous compounds resulted in maximum aggregate formation when the samples were air-dried before sieving. The increased aggregation might be mostly due to cohesive properties of the clay though the role of Dexon as a weak anion bridge between clay particles cannot be ruled out in this context. Curiously, we found (except in a few cases) air-drying had the effect of lowering water-stable aggregate in the samples. This, however, could be due to loss of clay cohesion and partial breakdown of the fungicide.

ACKNOWLEDGEMENT

The authors are thankful to Prof. J. V. Bhat for his keen interest in the work and to Bayer (India), Ltd., for the supply of Dexon. One of us (N. G. K. K.) is thankful to the C.S.I.R, for the award of Junior Research Fellowship.

1. Alconero, R. and Hagedorn, D. J., *Phytopath.*, 1968, **58**, 34.
2. Allen, R. N., *Aust. J. Exp. Agr. Anim. Husb.*, 1968, **8**, 767.
3. Tammen, J., Muse, D. P. and Haas, J. H., *Plant Dis. Reptr.*, 1961, **45**, 858.
4. — and —, *Ibid.*, 1961, **45**, 863.
5. Anderson, C. A. and Adams, J. M., *J. Agr. Food Chem*., 1963, **11**, 474.
6. Raabe, R. D. and Hurlimann, J. H., *Phytopath.*, 1965, **55**, 1072 (Abstr.).
7. Tiulin, A. F., 1928, Quoted by Baver, L. D., *Soil Physics*, 3rd edition, John Wiley and Sons, Inc., New York, 1956, p. 177.
8. Russel, E. W. and Russel, E. J., *Soil Conditions and Plant Growth*, 9th edition, Longmans, Green and Co., London, 1961, p. 121.
9. Harris, R. F., Chesters, G. and Allen, O. N., *Adv. in Agron.*, 1966, **18**, 107.

SPECTRAL AND MAGNETIC STUDIES ON URANYL (VI) COMPLEX OF 7-HYDROXY-4-METHYLCOUMARIN-6-CARBOXYLIC ACID

D. K. RASTOGI
Department of Chemistry, Meerut College, Meerut

COUMARIN derivatives have been successfully used as chelating reagents and their gravimetric and spectrophotometric studies in solution have been reported by several workers.[1,2] Rastogi *et al.*[3-5] have also studied the spectral and magnetic behaviour of several metal complexes of 8-amino-7-hydroxy-4-methylcoumarin (AHMC) and 7-hydroxy-4-methylcoumarin-6-carboxylic acid (HMCC). In this communication, HMCC has been found to form a light greyish-buff-coloured complex with UO_2(VI) ion, which has been isolated and characterised by analyses, magnetic, conductometric and spectral studies. Magnetic measurements reveal an anomalous magnetic behaviour (μ_{eff} 0·67 B.M.) which is due to temperature independent paramagnetism (TIP). Infrared spectral studies indicate the essentially ionic character of metal-oxygen bond.

Reagents.—7 - Hydroxy - 4-methylcoumarin-6-carboxylic acid (HMCC) was prepared by the method of Kumar.[6] All reagents used were of AnalaR grade. Magnetic, conductivity, u.v. and i.r. measurements were made as reported in the earlier communication.[7]

TABLE I

Magnetic and U.V. spectral data

Compound	Medium	Observed bands cm^{-1}	Assignment	Temp. °K	$\chi_M \times 10^6$ c.g.s. units	$\chi_M \times 10^6$ c.g.s. units	μ_{eff} B.M.
$[UO_2(C_{11}H_7O_5)_2]2H_2O$ ..	Ethanol	32260 } 33480 } 40000	Charge-transfer L→L^0	300·4	2	185	0·67

where L, Ligand in uncombined state, L^0, Ligand in combined state.

TABLE II

Infrared spectra and tentative assignments of important bands (cm^{-1})

HMCC	$[UO_2(C_{11}H_7O_5)_2]2H_2O$	Assignments
..	3484 (s)	ν (OH) of H_2O
3535 (s)	..	ν (OH) of phenol
3068 (s)	3166 (s)	ν (C—H) ring
2950 (s)	..	ν (OH) of COOH group
1717 (s)	1622 (s)*	ν assym (C=O)
1668 (s)	..	..
..	1622 (s)	δ (OH) of H_2O
1585 (s)	1593 (msh)	..
1495 (s)	1534 (m)	..
1442 (s)	1454 (m)	..
1330 (s)	..	δ (OH) of phenol
1390 (s)	1370 (msh)	..
1365 (s)	..	..
1305 (s)	..	..
1285 (s)	1283 (s)	..
..	935 (s)	ν (UO_2) group
920 (wsh)	926 (ssh) }	δ (O—C=O) + δ(OH) out of plane
903 (m)	899 (msh) }	
880 (m)	.. }	
804 (m)	805 (m) }	δ (C—H) out of plane
758 (w)	798 (msh) }	
750 (w)	760 (m) }	

* Band due to $\overline{COO}$ group.

ISOLATION OF THE COMPLEX

Bis (7 - hydroxy - 4 - methylcoumarin - 6 - carboxylato) uranyl (VI) dihydrate.—On adding an aqueous solution of 0·02 M uranyl nitrate (75 ml) to a 0·02 M solution of HMCC in acetone (300 ml) a light greyish-buff-coloured precipitate was obtained, the pH of the reaction mixture being ~ 4·0. The precipitate was digested, filtered and washed successively with water, acetone and ether and dried *in vacuo* at room temperature. Yield 85%. Analyses of the compound showed its formula to be $[UO_2(C_{11}H_7O_5)_2]2H_2O$ which requires U, 31·97 ; C, 35·49 ; H, 2·43 ; H_2O, 4·83% and was found to have, U, 31·74 ; C, 34·98 ; H, 2·32 ; H_2O, 5·0%. It was sparingly soluble in ethanol and other common organic solvents. The presence of two water molecules was determined by loss in weight on heating large quantity of the compound (~ 0·4 g) for about 2-3 hours at 100-105° C. The compound decomposed at about 245° C.

DISCUSSION

Analytical results show a 1 : 2 (metal : ligand) stoichiometry. Conductance measurements in aqueous solution reveal that the complex is a non-electrolyte ($\Lambda m = 15·54$ mhos in 10^{-3} M solution).

As uranium (VI) has closed shells, all complexes of this state are expected to be diamagnetic in nature, however, Rastogi[8] and others[9] have observed a temperature independent paramagnetism for uranyl compounds. The magnetic moment value for the present uranyl compound is 0·67 B.M. which is much less than that expected for one unpaired electron and may be due to TIP. The ultraviolet spectra of the complex in ethanol show three bands appearing at 32260 cm^{-1}, 33480 cm^{-1} and 40000 cm^{-1} which have been assigned to charge-transfer from ligand to metal ion[10] and transition within the ligand.

The infrared spectra of HMCC show a strong band appearing at 3535 cm^{-1} which has been assigned to stretching vibration of the phenolic group, whereas the ν(OH) of the carboxylic group appears at 2950 cm^{-1}. On complexation, both the ν(OH) vibrations of phenolic and carboxylic group have been vanished, thus indicating the formation of metal-oxygen bonding. The spectrum of the complex shows a strong band at 3,484 cm^{-1} which may be due to stretching vibration of the water molecule, whereas the bending vibration of the water molecule appears at 1622 cm^{-1} which seems to have been coupled with stretching vibration of the carboxylate group. The bands at 1717 cm^{-1} and 1668 cm^{-1} observed in the spectrum of HMCC, which are due to undissociated carboxylic group, are absent from the spectrum of the complex. Instead, a strong band due to antisymmetric vibration of the ionised carboxylic group appears at 1,622 cm^{-1}. The absorption in this region indicates that the resonance of carboxylate ion is preserved in the complex and that metal to oxygen band must, therefore, be essentially ionic in character.

The strong band appearing at 935 cm^{-1} in the uranyl complex has been assigned to the stretching vibration of the uranyl ion. In other crystalline uranyl compounds, this vibration has been found to occur between 900-950 cm^{-1},[11,12] typically near 920 cm^{-1}.

---

1. Bhat, A. N. and Jain, B. D., *Talenta*, 1960, **5**, 271; 1960, **4**, 13.
2. Singh, H. B., *Ph.D. Thesis*, Delhi University, Delhi, (India) 1966.
3. Rastogi, D. K., Srivastava, A. K. and Agarwal, B. R., *Indian J. Chem.*, 1969, **7** (7), 732.
4. —, —, Jain, P. C. and Agarwal, B. R., *J. Inorg. Nucl. Chem.*, 1970, **32**, 3849.
5. —, *J. Less-Common Metals* (Communicated).
6. Kumar, S., *Ph.D. Thesis*, Agra Univ., Agra, India, 1966.
7. Rastogi, D. K., Srivastava, A. K., Jain, P. C. and Agarwal, B. R., *J. Less-Common Metals*, **1971**, **24**, 383.
8. —, —, — and —, *Chimie Analytique* (*Paris*) (In press).
9. Nigam, H. L., Mathur, V. K. and Srivastava, S. C., *Bull. Chem. Soc. Japan*, 1963, **36** (12), 1658.
10. Jorgenson, C. K., *Acta Chem. Scand.*, 1957, **11**, 166.
11. Comyns, A. E., Gatehouse, B. M. and Wait, E., *J. Chem. Soc.*, 1958, p. 4655.
12. Sacconi, L., Cartori, G. and Paoletti, P., *Chemistry of Co-ordination Compounds: A Symposium of the Italian Chemical Society*, 1957, p. 93.

MICROWAVE SPECTRUM OF 2-CYANOPYRIDINE

S. DORAISWAMY AND S. D. SHARMA

Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay-5, India

THE microwave spectrum of 2-cyanopyridine (Fig. 1) has been investigated in the frequency range 8 to 18 GHz using a conventional 100 KHz Stark modulated microwave spectrometer.[1] Since the molecule has a very low vapour pressure at dry ice temperature, the spectrum was observed at room temperature. The pressure was maintained around 5 microns for most of the measurements. The molecule exhibits a rich spectrum with a line every 10 to 15 MHz. Most of the lines are broad and have observable quadrupole splittings.

The molecule was assumed to be planar. Using the pyridine ring dimensions as reported by Bak *et al.*[2] and taking the values of d_{cc} = 1·419 Å[3] and d_{CN} = 1·158 Å[3], the rotational constants come out to be A = 5868·96 MHz, B = 1658·16 MHz and C = 1292·88 MHz with the asymmetry parameter $\kappa = -0{\cdot}8404$. The spectrum was generated with these constants. Assignment of transitions was little difficult as Stark patterns were not clear for the lines expected to be of low J transitions and also because of the large number of lines. So the method adopted for the identification of the spectra was as follows: Based on intensity considerations and unresolved low J Stark patterns, lines were assigned to different transitions. A combination of four frequencies were chosen (in principle, any number of frequencies can be chosen for this purpose) and a matrix of the type

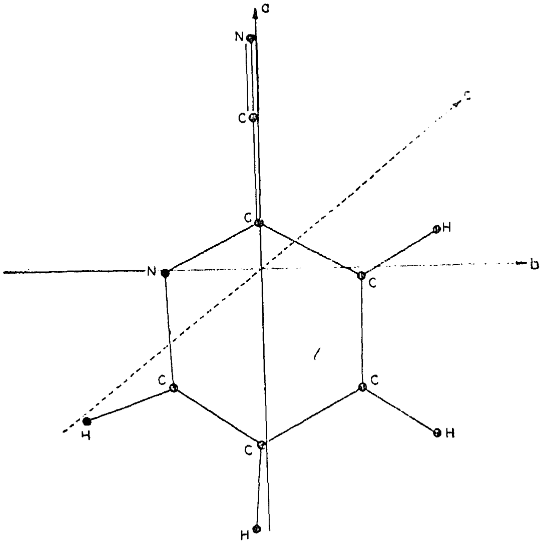


FIG. 1. 2–Cyanopyridine

$$\nu_i = [\Delta \langle P_{z_i}{}^2\rangle]A + [\Delta \langle P_{y_i}{}^2\rangle]C + [\Delta \langle P_{x_i}{}^2\rangle]B$$

was set up. Pierce's [4] computer program which calculates the rotational spectra from the given A, B and C was modified.[5] This program identifies the chosen combination of frequencies

TABLE I

Transition	$\nu_{\text{obs.}}$ (MHz)	$\nu_{\text{obs.}} - \nu_{\text{calc.}}$ (MHz)
3 (0, 3) – 2 (0, 2)	8478·41	+0·21
3 (1, 2) – 2 (1, 1)	9060·91	+0·17
3 (2, 2) – 2 (2, 1)	8558·00	−0·37
4 (0, 4) – 3 (0, 3)	11214·20	+0·21
4 (1, 4) – 3 (1, 3)	10385·34	+0·18
4 (1, 3) – 3 (1, 2)	12055·75	−0·06
4 (2, 2) – 3 (2, 1)	11591·55	−0·24
5 (0, 5) – 4 (0, 4)	13881·10	−0·01
5 (1, 5) – 4 (1, 4)	13323·70	+0·15
5 (2, 3) – 4 (2, 2)	14600·80	−0·11
5 (4, 2) – 4 (4, 1)	14308·00	+0·01
6 (0, 6) – 5 (0, 5)	16478·20	−0·13
6 (1, 6) – 5 (1, 5)	15943·70	+0·09
6 (2, 5) – 5 (2, 4)	17025·75	−0·22
6 (2, 4) – 6 (1, 5)	11119·70	−0·21
7 (1, 6) – 7 (0, 7)	10848·56	−0·07
8 (2, 6) – 8 (1, 7)	11197·20	−0·01
9 (2, 7) – 9 (1, 8)	11702·65	−0·20
11 (3, 8) – 11 (2, 9)	17502·30	−0·37
12 (2, 10) – 12 (1, 11)	15580·21	+0·13
12 (3, 9) – 12 (2, 10)	16979·15	−0·17
14 (3, 11) – 14 (2, 12)	16873·86	+0·02

TABLE II

Rotational constants and moments of inertia of 2-cyanopyridine

$A = 5836\cdot756 \pm 0\cdot014$ MHz	: $I_A = 86\cdot585$ amu Å^2
$B = 1598\cdot219 \pm 0\cdot004$ MHz	: $I_B = 316\cdot213$ amu Å^2
$C = 1254\cdot460 \pm 0\cdot004$ MHz	: $I_C = 402\cdot865$ amu Å^2
$\chi = -\ 0\cdot84996$	$\Delta = I_C - I_A - I_B = 0\cdot067$ amu Å^2

Conversion factor : 505376 MHz amu Å^2.

and determines the new values of A, B and C obtained by solving the matrix by the method of least squares. In the next iteration, the coefficients of A, B and C are calculated from their new values. Iterations are continued till the difference between the two consecutive sets of rotational constants do not exceed a preset limit. In this case, a limit of 0·01 MHz had been set. The entire spectra of the molecule are generated from the values of rotational constants obtained this way. This is subsequently compared with the observed frequencies. Any number of sets could be tested at a time.

The assignment of the spectrum thus obtained has been confirmed by the usual Q line plot. Further confirmation is provided by observing the Stark patterns of low J lines predicted by these constants and the relative intensities of other lines.

The observed and calculated frequencies are listed in Table I. Table II gives the molecular constants that give the best fit to the spectra.

The evaluation of dipole moment, quadrupole coupling constants and centrifugal distortion constants are in progress and will be published later.

---

1. Sharma, S. D. and Doraiswamy, S., *Proc. Ind. Acad. Sci.*, 1968, **67**, 12.
2. Bak, B. *et al.*, *J. Mol. Spectry.*, 1958, **2**, 361.
3. Lide, D. R., *J. Chem. Phys.*, 1954, **22**, 1577.
4. Pierce *et al.*, *Ibid.*, 1963, **38**, 330.
5. Sharma, S. D., wrote the computer program.

BIOLOGY TEACHERS' HANDBOOK*

THIS publication is a production of the Biological Sciences Curriculum Study (BSCS), USA. The BSCS was established in 1958 for the improvement of biological education at all levels. As a co-operative enterprise between the biological and educational communities, the BSCS has produced a variety of materials used at both the secondary and collegiate levels. The single most important factor in making these materials reach the students is the teacher. Hence the BSCS also brings out carefully planned handbooks to act as guidelines to biology teachers. With modal methodologies and resource materials added, such handbooks might also serve in the training of teachers.

The first U.S. edition of this Handbook was published in 1963 and the second U.S. edition in 1970 at $ 8.95. This book is now made available as a less expensive Wiley Eastern Reprint. The Indian publication is timely as there is an awareness in the country now to teach bioscience as an integrated course from high school onwards.

---

* *Biology Teachers' Handbook*, Second Edition. Supervisor Evelyn Klinckman. (Wiley Eastern Private Ltd., Publishers, J. 41, South Extension 1, New Delhi-49), 1971. Pp. xv + 692, Price Rs. 32.

LETTERS TO THE EDITOR

DIELECTRIC CONSTANTS OF THE SYSTEM X $Sm_3NbO_7 + (1 - X) La_3NbO_7$

THE structural properties of the above system have been recently reported.[1] The aim of the present note is to study the dielectric properties of the system X $Sm_3NbO_7 + (1 - X) La_3NbO_7 (0 \leqslant X \leqslant 1)$. The dielectric constant (ϵ) and loss tangent ($\tan \delta$) were measured on circular pellets of 12 mm diameter and about 1-2 mm thickness by the same methods as described earlier.[2] The results are shown in Table I.

TABLE I

Dielectric constants and loss tangent of the X $Sm_3NbO_7 + (1 - X) La_3NbO_7$ compositions at 25° C, 1 KHz, 50 v/cm

X	Structure* type	Dielectric constant (ϵ)	$\tan \delta \times 10^2$
0	W	800	2·0
20	W	660	1·6
30	W	565	1·2
40	W	495	1·8
50	W	400	2·0
60	W	300	2·3
80	P+W	220	5·0
100	P	240	2·1

* W = Orthorhombic Weberite type, P = Cubic defect fluorite (Pyrochlore) type. See reference (1),

It may be seen that the ϵ and $\tan \delta$ values go on decreasing with increasing X. This seems to be connected with the strain in the lattice which goes on increasing with X till the critical value of $X \geqslant 80$ mole% is reached. It is also observed that at this critical composition the ϵ and $\tan \delta$ values show a minimum and a maximum respectively. Similar observations have been previously recorded.[3] The minimum value of ϵ (220) corresponding to the appearance of a cubic pyrochlore phase is comparable to that reported for $Pb_2Nb_2O_7$, also crystallising with the pyrochlore structure ($\epsilon = 185$).[4] The reason why the ϵ values seem to be related to the strain may be sought in the change in the covalent character of the A site cation (La^{3+} and Sm^{3+}) in the 12-fold co-ordination, this character increasing[5] as the ionic size decreases ($La^{3+} = 1 \cdot 14$ Å, $Sm^{3+} = 1 \cdot 00$ Å).[5] This increase in the covalent character seems to be associated with a decrease in the effective polarizability of ions at the A site as La^{3+} ($5d^1 6s^2$) is slowly replaced by Sm^{3+} ($4f^6 5d^0 6s^2$) and thereby resulting in a decrease in ϵ with X.

Dept. of Physical and Solid-State Chemistry,
Institute of Science,
Nagpur, *April* 6, 1971.
V. S. CHINCHOLKAR.

---

1. Thakre, O. B., Patil, P. V. and Chincholkar, V. S., *Curr. Sci.*, 1971, **40**, 62.
2. Chincholkar, V. S., Menezes, C. A. and Biswas, A. B., *Ind. J. Pure. Appl. Phys.*, 1970, **8**, 707.
3. —, *Z. Angew. Physik*, 1970, **28**, 288.
4. Jaffe, H. F., *J. Am. Ceram. Soc.*, 1958, **41**, 494.
5. Schneider, S. J., Roth, R. S. and Waring, J. L., *J. Res. NBS*, *A*, 1961, **65 A**, 345.

OXYMERCURATION-DEMERCURATION OF ACETYLENES

THE oxymercuration reaction combined with the reduction of the oxymercurial intermediate by sodium borohydride provides a convenient method to achieve Markownikov's hydration of carbon-carbon double bonds without any observable rearrangement.[1,2] It has been shown[3] that the strain in the olefin plays an important role in the mode of addition, *e.g.*, *cis*-cyclooctene undergoes normal *trans*-addition while *trans*-cyclooctene gives *cis*-addition product. Recently, it has been shown that the addition is not controlled by steric factors in the case of bicyclic olefin like 7, 7-dimethylnorbornene and it gives exclusively *exo*-alcohol. A study has now been made to extend this reaction to representative acetylenes like 1-octyne, 3-hexyne, cyclotridecyne, phenylacetylene and diphenylacetylene to find the effect of the substituent on the yield of the ketone formed.

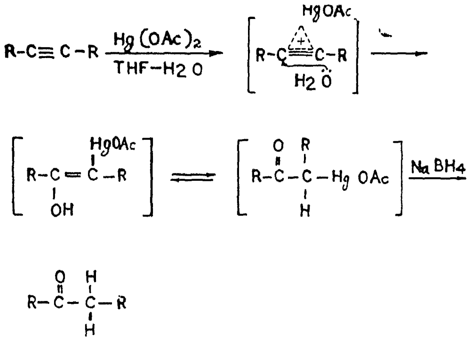
The acetylenes, 1-octyne, 3-hexyne, cyclotridecyne, phenylacetylene and diphenylacetylene were synthesized by known procedure and characterised by comparison of vapour phase chromatographic retention times and IR spectra with authentic samples. The respective acetylene (30 mmole) was oxymercurated with mercuric acetate (30 mmole) in tetrahydrofuran (30 ml)-water (30 ml) system. The yellow colour of the reaction mixture disappeared in 20 seconds and it was stirred for 10 min at room temperature to complete the reaction. The demercuration of the respective oxymercurial

TABLE I

Acetylenes		Ketones	Melting point and mixed m.p. of 2 : 4-dinitrophenyl hydrazones	Percentage yield of ketone
1. 1-Octyne	..	2-Octanone	56– 57°	70·0
2. 3-Hexyne	..	3-Hexanone	127–129°	83·3
3. Cyclotridecyne	..	Cyclotridecanone	114–115°	78·0
4. Phenylacetylene	..	Acetophenone	235–236°	55·1
5. Diphenylacetylene	..	No reaction	..	..

(without isolation) was done by adding 30 ml of 3 M sodium hydroxide followed by 30 ml of 0·5 M sodium borohydride in 3 M sodium hydroxide. The recovery of the reaction product was carried out according to Moon and Waxman.[5] The reaction mixture was neutralised by cautious addition of 3 M hydrochloric acid (just neutral). The water-tetrahydrofuran mixture was decanted from mercury and thoroughly extracted with benzene. The benzene layer was washed with water, separated and dried (anhydrous magnesium sulphate). After removal of the solvent, the residue was distilled under reduced pressure to obtain the reaction product. The ketones were characterised by their physical properties, vapour phase chromatographic analysis, IR spectra and determination of mixed melting points of 2 : 4-dinitrophenylhydrazone derivatives. The results are shown in Table I.

The formation of the ketones from terminal and internal acetylenes can be visualised as follows :



All the alkyl-substituted acetylenes underwent 100% conversion while phenylacetylene underwent conversion only upto 55·1%. Diphenylacetylene did not undergo oxymercuration reaction under similar conditions. This difference in reactivity could be dictated solely by the electronic factor. The steric effect seems to be of secondary importance in these reactions. Our results clearly point out that the electron-withdrawing power of phenyl group makes the acetylenic bond less prone to electrophilic attack by the electrophile Hg ⊕ OAC.

The oxymercuration of cyclotridecyne provides a convenient method of synthesising cyclotridecanone as the synthesis of cyclotridecyne can be achieved in two steps starting from readily available cyclododecene.[6,7]

Dept. of Chemistry, G. CHANDRA.*
Indian Inst. of Tech., D. DEVAPRABHAKARA.
Kanpur, March 25, 1971. M. S. MUTHANA.

---

* Department of Chemistry, H.B. Technological Institute, Kanpur.

1. Brown, H. C. and Geoghegan, P. (Jr.), *J. Am. Chem. Soc.*, 1967, **89**, 1522.
2. —, and Hammar, J., *Ibid.*, 1967, **89**, 1524.
3. Sokolov, V. I., Troitskaya, L. L. and Reutov, O. A., *Dokl. Akad. Nauk. SSSR.*, 1966, **166**, 136; *Chem. Abstr.*, 1966, **64**, 11246.
4. Brown, H. C., Kawakami, J. H. and Ikegami, S., *J. Am. Chem. Soc.*, 1967, **89**, 1525.
5. Moon, S. and Waxman, B. H., *Chem. Commun.*, 1967, p. 1283.
6. Nozaki, H., Kato, S. and Noyori, R., *Can. J. Chem.*, 1966, **44**, 1021.
7. —, Aratani, T. and Noyori, K., *Tetrahedron*, 1967, **23**, 3645.

SOME HYDRAZONES OF 5-BROMO- AND 5, 7-DIBROMO-COUMARALIC ACID HYDRAZIDES AS POSSIBLE ANTITUBERCULAR AGENTS

WITH a view to study antitubercular activity, hydrazones of 5-bromo-, and 5, 7-dibromocoumarilic acid hydrazides have been prepared. These hydrazides were obtained by the action of hydrazine hydrate on 5-bromo, and 5, 7-dibromo-2-carbethoxy coumarones. All the ketonic compounds, selected in this work, have hydroxyl group in *ortho* position. This may make a significant contribution to the activity because of the possibility of a chelate ring formation by hydrogen-bonding between the hydroxyl group and the terminal nitrogen of the hydrazones.

EXPERIMENTAL SECTION[1]

5-Bromocoumarilic Acid Hydrazide.—To a solution of 5-bromo-2-carbethoxy coumarone[2]

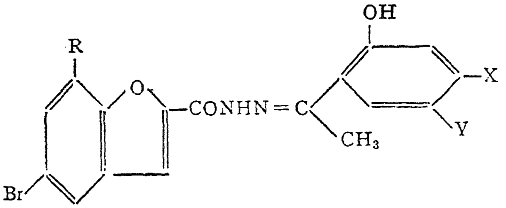
(·01 mole) in absolute ethanol (25 ml), 99% hydrazine hydrate (·015 mole) was added. The reaction mixture was refluxed for 4 hr. Ethanol and excess of hydrazine hydrate were removed under reduced pressure. The hydrazide which separated out was crystallized from ethanol, yield 80%, m.p. 175°, Anal. ($C_9H_7BrO_2N_2$). Found: C, 42·10; H, 2·50; N, 10·80; Required C, 42·35; H, 2·74; N, 10·98%.

5, 7-Dibromocoumarilic Acid Hydrazide.—This was prepared from 5, 7-dibromo-2-carbethoxy coumarone[2] by the above procedure, yield 75%, m.p. 228°, Anal. ($C_9H_6Br_2O_2N_2$). Found: C, 32·40; H, 1·75; N, 8·20; Required C, 32·33; H, 1·79; N, 8·30%.

Hydrazones (Table I).—An ethanolic solution of ketone (·01 mole), hydrazide (·01 mole) and sulphuric acid (0·1 ml) was refluxed for 2 hr. The reaction mixture was cooled and filtered. The solid thus obtained was crystallized from ethanol-acetic acid mixture.

TABLE I

Hydrazones



No.	R	X	Y	Yield %	M.P. °C	% Nitrogen Found	% Nitrogen Required
1.	H	OH	Br	80	280	6·00	5·98
2.	H	OH	NO_2	76	270	9·55	9·67
3.	H	H	Cl	85	256	6·70	6·87
4.	H	H	CH_3	72	164	7·00	7·23
5.	H	CH_3	Cl	65	242	6·70	6·64
6.	Br	OH	Br	75	234	5·25	5·11
7.	Br	OH	NO_2	78	238	8·10	8·18
8.	Br	H	Cl	82	232	5·50	5·75
9.	Br	H	CH_3	68	205	6·04	6·00
10.	Br	CH_2	Cl	74	224	5·60	5·59

Dept. of Chemistry, SATYENDRA KUMAR.*
S.S.V. College, R. P. MAHESH.
Hapur (U.P.), *April* 3, 1971.

---

* Present address: Research Division, Cleveland Clinic, Cleveland, Ohio, U.S.A.

1. Melting points are taken in capillaries and are uncorrected.
2. Rajeshwar Kurdukar and Subba Rao, N. V., *Proc. Indian Acad. Sci., Sec. A*, 1963, **58** (6), 336

SYNTHESIS OF SUBSTITUTED AZOXY-BENZENES

A SURVEY of chemical literature shows that nitrobenzenes have been reduced to a variety of products by means of different reducing agents.[1-10] With an alkaline medium, the formation of azoxy compound was favoured. Reduction with sodium and potassium methoxides proved to be efficient.

Very little work has been done to reduce substituted nitrobenzenes in neutral medium, with zinc in presence of ammonium chloride in aqueous-alcohol medium. In 1966,[11] we reduced o-nitro-acetanilide by the above method and got *o*-azoacetanilide and *o*-azoxy acetanilide in good yield.

In the present work we have developed the methods for the reduction of *ortho-* and *para-*toluenes, o- and p-chloronitrobenzenes, o- and p-nitrophenols with zinc and ammonium chloride in aqueous-alcohol medium to the respective azoxy compounds in good yield.

EXPERIMENTAL

In a preliminary survey, some of the variables affecting the reduction were studied. The variables examined were temperature, time, concentration of reactants and rate of stirring. A set of standard conditions were set up as follows:

To *o*-nitrotoluene (25 g) and ammonium chloride (15 g) stirred vigorously in alcohol (200 ml 50%) in a three-necked flask at 40° C, zinc dust (25 gm) was added slowly over a period of 30 min. The reaction mixture was kept stirred for about 2 hr more and then filtered. The residue was extracted with alcohol. The alcohol extract was mixed with filtrate and distilled to remove most of the alcohol, then subjected to steam distillation. The distillate was acidified and extracted with ether to recover unreacted *o*-nitrotoluene (6·9%). The acidified distillate after removing unreacted material with ether was made alkaline and then extracted with ether to get amino compound, *o*-toluedene (1·5%). The mixture from steam distillate remaining in the distillation flask was filtered to give a brownish-yellow residue of 2-2′-dimethyl-azoxy-benzene (52%) which was crystallised from ethanol as yellow needles m.p. and mixed m.p. 58-59° C (Lit. 60° C).

All the products were identified by mixed m.p., carbon, hydrogen and nitrogen analysis and by infrared spectroscopy with a Perkin-Elmer infracord 137 B spectrophotometer,

TABLE I

Nitro compounds successfully reduced to azoxy compounds

Sl. No.	Nitro compounds	Weight of the nitro compound taken (gm)	Weight of the zinc powder (gm)	Ratio of alcohol/water (cc/cc)	Weight of ammonium chloride taken (gm)	Temperature (°C)	Formula of the azoxy compound	Yield of the azoxy compound (%)
1	*o*-Nitrotoluene ..	25	25	100 100	15	40	$C_{14}H_{14}ON_2$	52
2	*p*-Nitrotoluene ..	10	10	120 50	10	55	$C_{14}H_{14}ON_2$	57·5
3	*o*-Nitrophenol ..	25	20	100 150	15	30	$C_{12}H_{10}O_3N_2$	53·4
4	*p*-Nitrophenol ..	25	20	100 130	15	55	$C_{12}H_{10}O_3N_2$	61·9
5	*o*-Chloronitrobenzene ..	25	35	150 200	25	55	$C_{12}H_8O_2N_2Cl_2$	57·2
6	*p*-Chloronitrobenzene ..	25	35	200 200	15	30	$C_{12}H_8O_2N_2Cl_2$	62·7

TABLE II

Analysis of azoxy compounds

Sl. No.	Azoxy compound	M.P. °C	Nitrogen %		Carbon %		Hydrogen %	
			Calculated	Found	Calculated	Found	Calculated	Found
1	2-2′ Dimethyl-azoxy-benzene	58– 59	12·38	12·26	74·32	74·58	6·23	6·29
2	4-4′ Dimethyl-azoxy-benzene	69– 70	12·38	12·31	74·32	74·61	6·23	6·28
3	2-2′ Dihydroxy-azoxy-benzene	154–155	12·18	12·29	62·61	62·35	4·38	4·17
4	4-4′ Dihydroxy-azoxy-benzene	224–225	12·18	12·32	62·61	62·85	4·38	4·15
5	2-2′ Dichloro-azoxy-benzene	55– 56	10·48	10·35	53·95	53·65	3·02	3·08
6	4-4′ Dichloro-azoxy-benzene	156–157	10·48	10·57	53·95	53·58	3·02	3·07

These experiments indicate that: (1) The temperature of reaction is of critical importance between 30-55° C, higher temperature favours the formation of tar material while lower temperature decreases the yield of azoxy compound. (2) Prolonging the reaction beyond 2½ hr has no effect on the yield, which drops with shorter reaction time. (3) 7·5% ammonium chloride appears to be the optimum concentration. The conversions drop off slightly with higher concentration of ammonium chloride and falls rapidly with less than 6% ammonium chloride. (4) Under the conditions studied increasing the quantity of Zn increases the conversions upto the point where 2 moles of zinc were used per mole of substituted nitrobenzenes. Decreasing the quantity of zinc reduces the yield. (5) The importance of adequate mixing is shown by the linear relationship between the rate of stirring and the conversion. For some of the compounds studied, it is necessary to alter some of the conditions to obtain satisfactory yield. The results of successful reductions are shown in Table I and the analysis of resulting compounds is shown in Table II. *m*-Nitrotoluene, *m*-nitrophenol and *m*-nitrochlorobenzene were also reduced by the same process but the yields of the respective azoxy compounds were very poor and less than 10%. The nitro compounds whose attempted reduction was unsuccessful include *m*-dinitrobenzene, *p*-nitro aniline, 2-nitro-4-methyl aniline and 2-chloro-4-nitro-aniline.

Explosives Res. and Development Lab.,
Pashan, Poona-21 (India),
April 3, 1971.

KUNWAR BAHADUR.
S. K. SINHA.

---

1. Klinger, P. and Pitschke, T., *Ber.*, 1885, **18**, 2552.
2. Elbs, K., *Chem. Ztg*, 1893, **17**, 209.
3. Zechmeister, L. and Rom, P., *Ann.*, 1928, **468**, 117.
4. Loesner, H. J., *Prakt. Chem.*, 1894, **50**, 563.
5. Gaudry, R. and Keistead, K. F., *Can. J. Research*, 1949, **27**, 890.
6. Bigelow, H. E. and Palmer, A., *Org. Synthesis*, 1943, **2**, 59.
7. Galbraith, H. W. *et al.*, *J Am. Chem. Soc.*, 1951, **73**, 1323.
8. Paul, E. *et al.*, *Can. J. Chem.*, 1957, **35**, 1304.
9. Brain, T., Newbold and Raymond, P., Le-Blanc, *J. Org. Chem.*, 1962, **27**, 312
10. —, — and —, *J. Chem. Soc.*, 1965, p. 1546.
11. Kunwar Bahadur, Rao, K. R. K., and Sinha, S. K., *Jour. Indian Chem. Soc.*, 1966, **43**, 725.

FLAVONOIDS OF *THUNBERGIA GRANDIFLORA* AND *ASYSTASIA TRAVANCORICA*

In continuation of our earlier work on the flavonoids of *Acanthaceae*[1-3] and in view of the isolation of scutellarein and its 7-rhamnoglucoside from *Barleria prionitis*[4] of this family for the first time, it was considered desirable to examine more members of the family; the flowers of *Thunbergia grandiflora* Roxb. and the leaves and flowers of *Asystasia travancorica* Bedd. collected from Pondicherry have been systematically examined for their flavonoids adopting the well established methods[5,6] and our results are recorded in brief.

T. grandiflora.—The major flavonoid glycoside isolated from a hot methanolic extract of the flowers of *T. grandiflora* did not have sharp melting, but sintered at about 240° C and decomposed at 320-25° C. It was fairly soluble in water, sparingly soluble in alcohol and acetone and insoluble in ether and benzene. It was laevo rotatory, $[\alpha]_D^{28}$-92° (1·0%, H_2O). It gave a crystalline acetate, m.p. 232-33° C and a crystalline methyl ether, m.p. 220-22° C. It could not be hydrolysed with 7% H_2SO_4 in 2 hr, but underwent hydrolysis when refluxed with 10% H_2SO_4 in HOAc medium for 5 hr and yielded apigenin and glucuronic acid, which were fully characterised by preparation of derivatives and direct comparison with authentic samples. The glycoside could also be hydrolysed by β-glucuronidase. The UV absorption max. of the glycoside (269, 337 nm) was almost the same as for apigenin and showed no shift of Band II with NaOAc. The i.r. spectrum showed bands at 3410, 1665, 1605, 1495, 1415, 1345, 1295, 1250, 1200, 1170, 1095, 1050, 1030, 830 and 810 cm^{-1}, similar to apigenin. The glycoside methyl ether on hydrolysis (10% H_2SO_4 in HOAc medium, 5 hr) yielded 7-hydroxy-5, 4'-dimethoxy flavone, m.p. 261-63° C (no Fe^{3+} colour). From the above data, the compound was identified as apigenin-7-glucuronide. The other flavonoid pigments were identified as luteolin and luteolin-7-glucoside by co-chromatography. The anthocyanin was found to be malvidin-3, 5-diglucoside.

A. travancorica—The flavonoids of the flowers of *A. travancorica* were separated by preparative PC. The chalcone glucoside was identified as isosalipurposide by characteristic colour reactions, R_f in different solvent systems, formation of naringenin and glucose on acid hydrolysis and co-chromatography with an authentic sample from *Rungia repens*.[3] Other flavonoid pigments were identified as apigenin-7-rutinoside and apigenin-7-glucoside. The anthocyanin was found to be delphinidin-3, 5-diglucoside.

The leaves of *A. travancorica* contained apigenin-7-glucuronide, isosalipurposide and small quantities of a flavanone.

This is the first record of isolation of a flavone uronide in *Acanthaceae* whose presence is recorded in related families of the *Tubiflorae*.[7] The flavonoid pattern of *A. travancorica* resembles that of *A. gangetica*[8] and *R. repens*[3] of the same family.

We thank Prof. T. R. Govindachari, Director, Ciba Research Centre, Goregaon, Bombay, for the spectral data, Dr. J. Jayaraman, Department of Biological Sciences, University of Madurai, for β-glucuronidase, and the Principal, JIPMER, for encouragement.

Dept. of Chem., S. Sankara Subramanian.
JIPMER, A. G. R. Nair.
Pondicherry-6, *April* 6, 1971.

---

1. Subramanian, S. S. and Nair, A. G. R., *Indian J. Chem.*, 1964, **2**, 238.
2. Nair, A. G. R., Nagarajan, S. and Subramanian, S. S., *Curr. Sci.*, 1965, **34**, 79.
3. Subramanian, S. S., Joseph, K. J. and Nair, A. G. R., *Phytochem.*, 1969, **8**, 319.
4. Harborne, J. B., Subramanian, S. S. and Nair, A. G. R., *Ibid.*, 1971, **10**, (in press).
5. Geissman, T. A., *The Chemistry of Flavonoid Compounds*, Pergamon Press, London, 1962.
6. Mabry, T. J., Markham, K. R. and Thomas, M. B., *The Systematic Identification of Flavonoids*, Springer-Verlag, 1970.
7. Harborne, J. B., *Comparative Biochemistry of the Flavonoids*, Academic Press, 1967, p. 216.
8. —, *Phytochem.*, 1966, **5**, 111.

ON THE NATURE OF THE CONTACT BETWEEN GWALIOR "SILL" AND KAIMUR SANDSTONE AROUND GWALIOR : MADHYA PRADESH

Around the City of Gwalior (78° 15'-26° 14') rocks of Gwalior Series of Cuddapah age (Crawford and Crompston, 1970) have been overlaid by Upper Vindhyan formations, *viz.*, Kaimur Sandstone and Rewa Shales and Sandstones (Pascoe, 1963, p. 290). Gwalior Series consists of lower Par Stage and upper Morar Stage, unconformably deposited over Bundelkand Gneiss. Basic igneous rocks occur in Morar Stage at two horizons: the lower, smaller one with a maximum thickness of 25 m, well exposed at about 11 km south-west of the City of Gwalior and the upper, bigger formation mostly about 170 m thick with very good exposures in the undercliff of the fort-hill near Gwalior and in several other places in the surrounding area, under similar situation. It is with the nature of the contact between the upper igneous formation and the overlying Kaimur Sandstone, that the present paper deals.

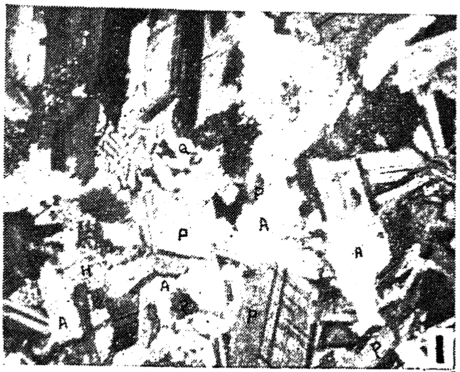
Gwalior 'Sill'.—The upper igneous formation has an extensive spread parallel to the bedding plane. It extends for a length of about 80 km from Bitholi in the west to Jhankri in the east, and a width of about 24 km. Towards the western end it is covered by thick layers of Kaimur Sandstone and along the eastern margin by alluvium. Throughout this extent the formation does not seem to thin out; evidently it extends beyond.

These basic rocks have been regarded as dioritic lavas by Dubey (1930) and as volcanics by Mathur (1964) and Crawford and Crompston (1970). Hacket (1871) and Pascoe (1963), however, describe them merely as traps. Verma, Roonwal and Chaku (1970) suggest that they might be intrusives. These basic rocks do not exhibit any structure or texture characteristic of lava flows. Megascopically, the rock is dark grey, compact and medium-grained. In thin sections, the rock is holocrystalline, equigranular to porphyritic and exhibits ophitic and micropegmatitic textures (Fig. 1). It contains plagioclase and augite with accessory magnetite, ilmenite and quartz, the last present only in the upper levels. Secondary hornblende, biotite, chlorite and calcite are also present. Plagioclase is labrodorite in composition. The formation is a dolerite *Sill* becoming quartz dolerite in the upper level. Detailed petrological study of the formation is underway.

Contact between Gwalior Sill and Kaimur Sandstone.—A detailed study of the Gwalior Sill and the Kaimur Sandstone has revealed the following facts:

(1) The basic sill has undergone weathering for a depth of about 25 m from its surface. Dark and compact dolerite gradually becomes lighter-coloured and gritty, forming veinlets of kankar due to weathering. Very near the surface, the rock forms soft, yellowish-gray material.

(2) The sill is made of well-developed horizontal jointing, the width between the joint planes getting reduced towards the surface, from about 2½ m at a depth of 35 m to about 15 cm near the contact. Remarkably well-developed spheroidal weathering occurs between the joint planes. A very good development of spheroidal weathering is seen in the upper surface of the quarry near Ghosipur, worked for dolerite blocks.



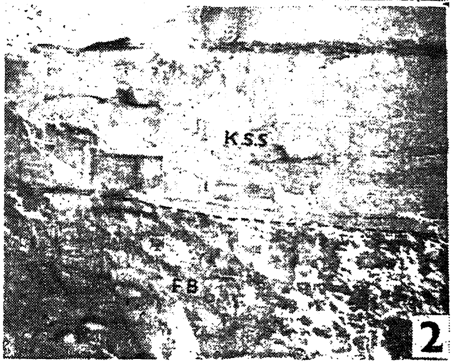


FIG. 1. Photomicrograph of a thin section of Gwalior sill from Ghosipur quarry showing ophitic and micropegmatitic textures. Minerals—P: Plagioclase, A: Augite, Q: Quartz and H: Hornblende. C. N., × 40.

FIG. 2. Fault breccia (F.B.) at the contact between Kaimur Sandstone (KSS) and underlying Gwalior Sill (not seen), along the eastern chiff of Gwalior fort-hill.

Weathering of dolerite to a depth of about 25 m from its surface and a uniform development of spheroidal weathering to a similar depth clearly shows that the rock had been exposed to weathering for a long time.

(3) Generally, fault breccia occurs between the dolerite sill and the overlying Kaimur Sandstone (Fig. 2), varying in thickness from a few inches to about 12 m as seen in the hillock southwest of Gwalior, on the road to Tigra Dam. It is important to note that the fault breccia consists of fragments of overlying sandstone and also red shales mixed up in a reddish-brown matrix, consisting of plenty of mica.

(4) The Kaimur Sandstone shows very little disturbance. Generally, it consists of massive sandstone. Near the contact, the thickness of sandstone beds gets reduced to about 2 cm or even less (Fig. 2). Incipient crystallisation with the formation of magnetite crystals is also noticed near the contact.

Fault breccia is developed after the formation of the Kaimur Sandstone. Verma, Roonwal and Chaku (1970) 'conjecture' the contact 'as indicative of dislocation'. The present study has revealed that the fault breccia is developed due to the movement of Kaimur Sandstone over the surface of the sill; the extent of the movement is, however, not clear. Perhaps a thin layer of Morar Shales, present over the sill surface, is removed during this movement. This explains the occurrence of shale fragments in the fault breccia. It is also observed that the stratigraphic position between the Gwalior Sill and Kaimur Sandstone is not affected during this movement. The authors, therefore, consider the contact between the two formations as a *'faulted contact'* and not as a *'thrust contact'*.

The authors are highly indebted to Prof. A. G. Jhingran for his constant encouragement and help during the present work.

Dept. of Geology, S. VARADARAJAN.
University of Delhi, V. K. VERMA.
Delhi-7, *March* 13, 1971.

1. Crawford, A. R. and Cromston, W., *Q.J.G.S.*, 1970. **125** (5), 320.
2. Dubey, V. S., *Nature*, 1930, **126**, 3186.
3. Hacket, C. A., *Rec. Geol. Sur. India*, 1871, **4**, 33.
4. Mathur, S. M., *XXII Int. Geol. Congress : Field Excursion 4 ; Guide Booklet*, 1964.
5. Pascoe, E., *A Manual of Geology of India and Burma*, 1963, **1**.
6. Verma, V. K., Roonwal, G. S. and Chaku, S. K., *Proc. Nat. Acad. Sci. India*, 1970, **40**, Pt. 4. Sec. B, 297.

PALAEOMAGNETISM AND THE PHENOMENON OF MULTIPLE INTRUSION

WHEN palaeomagnetic work was first initiated, its main purpose was confined to solving some of the geophysical problems like the origin and history of the geomagnetic field, continental drift and polar wandering. Its usefulness is now found in solving some of the geological problems, such as, age determinations (Blundell, 1961 ; Storetvedt, 1966), correlation (Khan, 1960 ; Radhakrishnamurthy, 1963), and classification (Sahasrabudhe, 1963 ; Strangway, 1964) of the rocks. The work of the present authors on the dolerite dykes of the Tirupati area also revealed the usefulness of the palaeomagnetic studies in establishing the phenomenon of multiple intrusion.

During the course of investigation of the dolerite dykes of the Tirupati area, a multiple intrusion was noticed about six miles south of Tirupati by the side of the Tirupati-Rayalchervu road near the village Gangireddipalli. The multiple intrusion is formed by an injection of a younger dyke into the older. The younger dyke occurs in the middle of the older dyke making chilled contacts with the latter as seen in Fig. 1, A and B. In the figure, only one contact plane is shown.

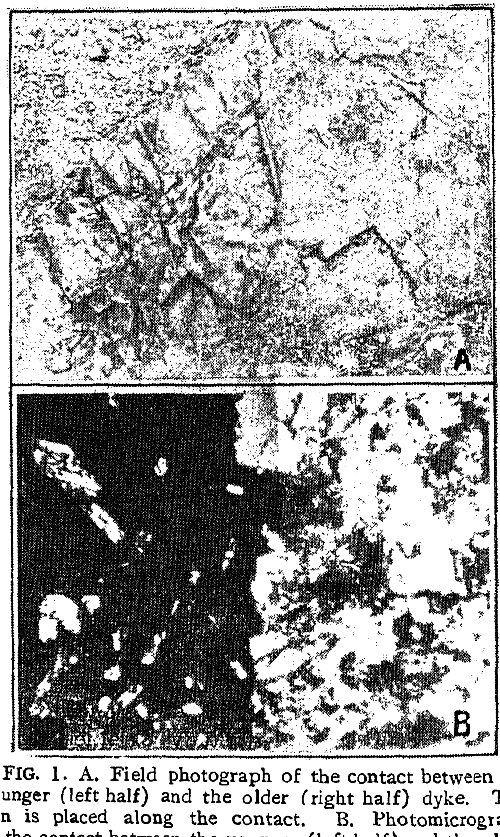


FIG. 1. A. Field photograph of the contact between the younger (left half) and the older (right half) dyke. The pen is placed along the contact. B. Photomicrograph of the contact between the younger (left half) and the older (right half) dyke.

Oriented samples were collected from both the dykes, and their natural remanent magnetic directions and intensities were measured using an astatic magnetometer. The results of the preliminary measurements are given in Table I, and the A.C. cleaned directions are shown in Fig. 2. From Table I and Fig. 2 it is evident that the older dyke is normally

TABLE I

	Specimen No.	Azimuth degrees E of N	Dip in degrees +ve downwards	Intensity $\times 10^{-3}$ e.m.u./gm
Order dyke	KP19*a*1	340	−22	0·403
	KP19*a*2	348	−19	0·412
	KP19*b*1	337	−16	0·354
	KP19*b*2	322	−14	0·304
	KP19*c*1	336	−23	0·287
	KP19*c*2	330	−20	0·299
Younger dyke	KP20*a*1	148	7	1·570
	KP20*a*2	156	10	1·656
	KP20*b*1	140	13	0·970
	KP20*b*2	158	15	0·908
	KP20*c*1	136	11	1·189
	KP20*c*2	145	8	1·233

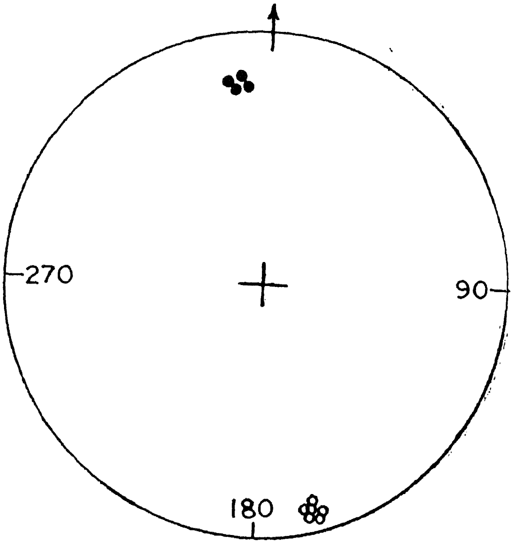


FIG. 2. A.C. cleaned directions for the older (solid circles) and the younger (open circles) dykes.

magnetized whereas the younger dyke is reversely magnetized. This indicates that these two dykes were magnetized in two different periods and hence they should belong to two different periods of dyke intrusion. This is a case where the field data and the palaeomagnetic results are in striking correspondence with each other, and makes a first reported case of such a study on the dyke rocks of India.

The authors thank Dr. C. Radhakrishnamurthy of Tata Institute of Fundamental Research, Bombay, for his helpful suggestions. Prof. D. Lal of Tata Institute of Fundamental Research kindly provided facilities in the rock magnetism laboratories. The authors also thank Professors M. G. Chakrapani Naidu, B. Mohan Rao, G. Ramakrishnan and Dr. C. V. R. K. Prasad of S.V. University for their help and encouragement.

Dept. of Civil Engg., K. ANJANAPPA.
Dept. of Geology, K. V. SURYANARAYANA.
S.V. University, Tirupati, *March* 24, 1971.

---

1. Blundell, D. J., *Geol. Mag.*, 1961, **98**, 301.
2. Khan, M. A., *Geophys. Jour.*, 1960, **3**, 45.
3. Radhakrishnamurthy, C., *D. Sc. Thesis*, Andhra University, 1963 (Unpublished).
4. Sahasrabudhe, P. W., *Ph.D. Thesis*, Banaras Hindu University, 1963 (Unpublished).
5. Storetvedt, K. M., *Norsk Geol. Tiddskr*, 1966, **23**, 175.
6. Strangway, D. W., *Jour. Geology*, 1964, **72**, 649.

AN INSTANCE OF HERMAPHRODITISM IN THE CAT-FISH, *HETEROPNEUSTES FOSSILIS* (BLOCH)

OCCURRENCE of hermaphroditism has been reported in several teleost fishes and the problem was reviewed extensively by Atz (1964). He pointed out that hermaphroditism appears to be a genuine rarity among the large and varied groups of cat-fishes. The only case reported by then among cat-fishes was in a male *Mystus vittatus* with oocytes in the testes (Singh and Sathyanesan, 1961). Later, Lehri (1964) recorded another hermaphrodite cat-fish, *Clarias batrachus* having left ovotestis and right testis. The present communication deals with the histomorphological aspects of the hermaphrodite gonads of *Heteropneustes fossilis* (Bloch), a cat-fish, in which no such phenomenon appears to have been reported so far.

During the course of an investigation on the gonads of *H. fossilis*, a 250 mm long specimen, when dissected, exhibited ovotestes on either side. Each ovotestis consists of a posterior ovarian part and an anterior testicular portion. The left testicular portion is broadly connected to the ovarian portion, whereas the right one is coherent by a comparatively narrow bridge (Fig. 1). The ovarian portions are dark brown in colour and moderately vascularized. The left ovarian part is almost cylindrical, while the right one is laterally compressed; the former is more turgid than its contralateral counterpart. The testicular portions are cream-coloured and flattened dorso-ventrally.

The ovarian portions taper posteriorly and become united to form a common duct. The measurements of the ovotestes are summarised in Table I. The mean gonosomatic index (weight of the gonads/weight of the body ×

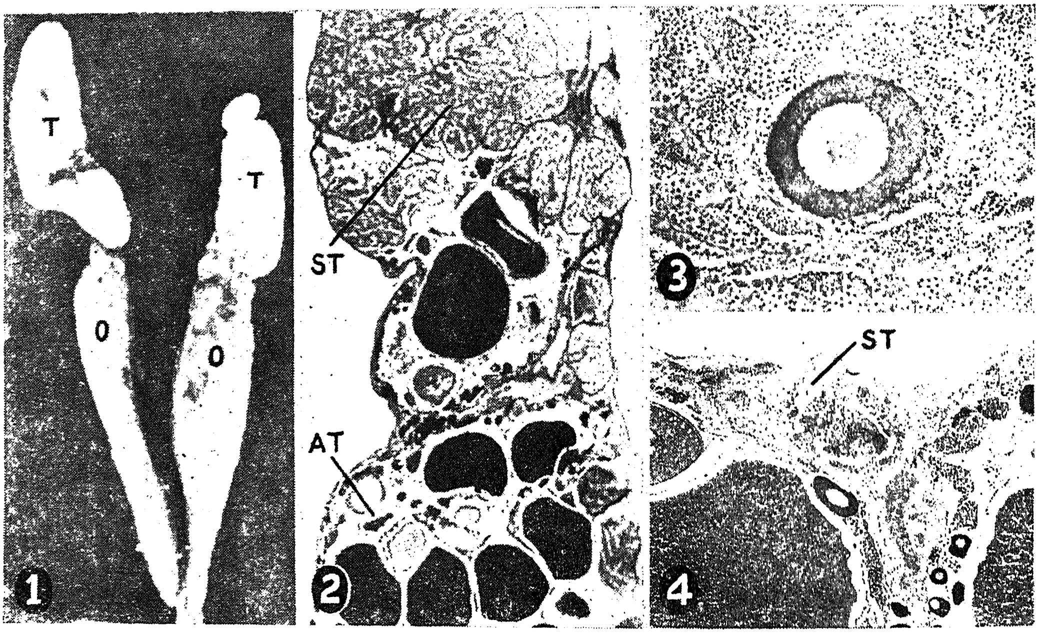
100) of the males collected during the same period is 0·869, whereas that of the females is 5·985. The gonosomatic index of the hermaphrodite fish is 1·208 the value being intermediate between those of the normal males and females.

TABLE I

Right ovotestis				Left ovotestis			
Testicular portion		Ovarian portion		Testicular portion		Ovarian portion	
Length (mm)	Breadth (mm)	Length (mm)	Breadth (mm)	Length (mm)	Breadth (mm)	Length (mm)	Breadth (mm)
12	6	25	5	12	5	25	6

The ovarian wall, though continuous with the testicular wall, is comparatively thick. There are a number of immature oocytes along the ovarian wall which are deeply stained with haematoxylin. Several luteal bodies are also present in the same region. The ovarian portions contain a large number of mature ova. Oocytes at perinucleolus stage, yolk nucleus stage and yolk vesicle stage are also present. Atretic follicles and several stages of atresia are also observed (Fig. 2).

Solitary oocytes are present in the interlobular space of testis far away from the ovotesticular junction (Fig. 3). On the other hand, some of the seminiferous lobules extend into the spaces between the ova (Fig. 4).



FIGS. 1–4. Fig. 1. Photograph of the entire hermaphrodite gonad of *Heteropneustes fossilis* showing the anterior testicular (T) and posterior ovarian (O) parts, × 1·8. Fig. 2. Photomicrograph of longitudinal section of the ovotestis passing through the ovotesticular junction; note oocytes at different stages, atretic follicles (AT) and seminiferous lobules (ST), × 16. Fig. 3. Section of the testicular part showing an embedded oocyte; note various spermatogenic stages, × 135. Fig. 4. Section of ovarian part showing a seminiferous lobule (ST), × 60.

The ovotestes are enclosed by a common sheath. The testicular wall is comparatively thin. Beneath the outer peritoneum, there is a layer of connective tissue which is richly supplied with blood vessels. The interlobular spaces are packed with connective tissue, interstitial cells and blood vessels. The walls of the lobules are distinct but thin. Almost all stages of spermatogenesis are present; spermatids and sperms outnumber all the other stages.

Another interesting feature is the occurrence of sperms in the ovarian lumen; they are sometimes present in close approximation with the oocytes.

In *Barbus stigma* (Sathyanesan, 1957), *Lebistes reticulatus* (Spurway, 1957), and *Mystus vittatus* (Singh and Sathyanesan, 1961), the testicular and ovarian tissues are interspersed with each other without any regular order. In the present case, however, the testicular and ovarian regions of the ovo-testes are clearly demarcated with the exception of a few sperms and oocytes occurring in the ovarian and testicular regions respectively. The condition, to certain extent, is comparable to that reported in *Clarias batrachus* (Lehri, 1964). The existence of sperms adjacent to oocytes is suggestive of their passage through the ovarian lumen to be extruded from the common genital duct.

Grateful thanks are due to Dr. S. M. H. Khatib, Professor and Head of the Department of Zoology, Nagpur University, Nagpur, for laboratory facilities and encouragement.

Dept. of Zoology, P. D. PRASADA RAO.
Nagpur University, D. R. PATIL.
University Campus,
Nagpur, *March* 27, 1971.

1. Atz, J. W., In: *Intersexuality in Vertebrates Including Man*, Eds., Armstrong, C. N. and Marshall, A. J., Academic Press, New York, 1964, p. 145
2. Lehri, G. K., *Curr. Sci.*, 1964, **33**, 529.
3. Sathyanesan, A. G., *Sci. and Cult.*, 1957, **23**, 203.
4. Singh, T. P, and Sathyanesan, A. G., *Curr. Sci.*, 1961, **30**, 302.
5. Spurway, H., *Nature*, 1957, **180**, 1248.

ON *CONGERIA SALLEI* RECLUZ, A FOULING BIVALVE MOLLUSC IN THE VISAKHAPATNAM HARBOUR

WHILE engaged in the studies of marine fouling organisms in the Visakhapatnam harbour, we suddenly came across in 1967 an exotic species of a bivalve mollusc in the Southern Lighter Channel. The mussel has been previously reported only from North American Atlantic Coast in South Florida and West Indies (personal communication from Dr. Ruth D. Turner, Harvard University, Cambridge, Massachusetts).

The family Dreissenacea to which the present bivalve belongs includes only two genera, namely, *Dreissena* and *Congeria*. The well-known species, *Dreissena polymorpha*, is almost exclusively a freshwater form and has been extensively studied in the Baltic, Caspian Sea, and the British freshwater reservoirs. Wiktor[1] has estimated that 87·7% of the whole biomass in the Szczecin lagoon in Poland is composed of *Dreissena polymorpha*. In Great Britain, Yonge and Campbell[2] and Brian Morton[3] have made extensive studies on the biology and ecology of this mussel from the London freshwater reservoirs where this form is found as obstructing masses on the walls of large diameter pipe-lines. It has been known to attach to almost any firm object including reeds, other bivalves, wood pilings, stone work, canal lock-gates, etc. *Dreissena polymorpha* is posing a menacing fouling problem in many European freshwater systems and also in the U.S.S.R.

It has been suggested that the ancestors of *Dreissena* and *Congeria* must have been marine animals which later became adapted to life in freshwaters. There is very little account of the fouling propensity of *Congeria*. The bivalve has firmly established in various locations in the local harbour on concrete pilings, large diameter cast iron pipe-lines discharging dredged material, the undersurface of barges and other crafts and rock boulders in shallow water. They appear as large bunches of 'grapes' attached to the substratum by byssus (Fig. 1). As many as 500 or more animals have been counted in a single bunch. The mussel grows to a length of about 30 mm. All size groups are found in the same bunch suggesting that the spats of the mussel settle down on the surface of the older ones adding progressively to the bulk of the bunch.

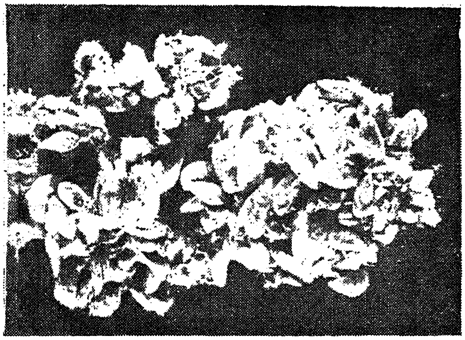


FIG. 1. Bunch of *Congeria sallei*.

Preliminary laboratory studies on the salinity tolerance of *Congeria sallei* have shown that the mussel is tolerant to a wide range of salinity ranging from 2·85‰ to 34·81‰. They, however, seem to prefer lower salinity ranges and are most abundant in locations where the salinity range is from 22‰ to 32‰. The mussel has also been observed to thrive well in locations subjected to heavy oil and other types of industrial pollutants in the harbour area.

It is obvious that *Congeria sallei* has been introduced in the local harbour by ships calling at the port from North American waters. Active studies are in progress, in the Department, on the biology and ecology of this mussel which is causing great concern to the harbour and naval authorities as a serious fouling problem.

We wish to express our grateful thanks to Dr. (Miss) Ruth D. Turner, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, for kindly identifying the mussel. The work was carried out with the funds provided by the Forest Research Institute, Dehra Dun, for the execution of the scheme for the 'Protection of Indian timbers against attack by marine organisms'.

Dept. of Zoology, P. N. GANAPATI.
Andhra University, M. V. LAKSHMANA RAO.
Waltair, A. G. VARGHESE.
March 22, 1971.

---

1. Wiktor, J., *Ekol. Pol.*, 1963, **11 A**, 275.
2. Yonge, C. M. and Campbell, J. I., *Trans. Roy. Soc. Edin.*, 1968, **68**, **21**.
3. Brain Morton, *Proc. malac. Soc. Lond.*, 1969, **38**, 301.

ON THE SIGNIFICANCE OF THE OCCURRENCE OF BLOOMS OF THE DIATOM *HEMIDISCUS HARDMANNIANUS* (GREVILLE) MANN IN RELATION TO HILSA FISHERY IN BENGAL

SEVERAL workers have reported the occurrence of planktonic indicator species in relation to certain commercial fisheries. In the North Sea, Savage and Wimpenny[1] observed greatest intensity of herring fishery close to the edge of concentrations of the diatoms *Rhizosolenia styliformis* and *Biddulphia sinensis*. In India, Nair and Subramanyan,[2] and Nair[3] have pointed out that the bloom of the planktonic diatom *Fragilaria oceanica* Cleve could be used as an indicator of the abundance of the oil sardine *Sardinella longiceps* Val. in the West Coast of India.

In the last week of June 1964, a sudden arrival of large shoals of hilsa, *Hilsa ilisha* (Ham.), was reported in the Lower Sundarban areas of the Hooghly-Matlah estuarine system in West Bengal, especially in the Matlah estuary, resulting in very heavy landings. This phenomenon coincided with the occurrence of a heavy bloom of the centric diatom *Hemidiscus hardmannianus* (Greville) Mann in the Matlah estuary, almost to the complete exclusion of other plankters, as observed in the routine plankton collection made on 25-6-1964. The high tide collection of the day recorded as many as 2,976 numbers of this diatom per litre. The plankton concentrate obtained from filtering 150 litres of the Matlah water had a wet volume of as much as 25 ml, consisting almost wholly of this diatom. On the other hand, it was totally absent during the earlier fortnight and in May, and was found to have almost disappeared in the subsequent fortnight's collection on 10-7-1964. This tropical diatom is macroscopic and appears like the segment of an orange (Fig. 1). It is visible to the naked eye as a granular suspension in water. Its heavy concentration gives a glistening granular appearance to the water. The local fishermen describe these as "eggs of hilsa", and they believe the bloom to be a precursor of the arrival of hilsa shoals.

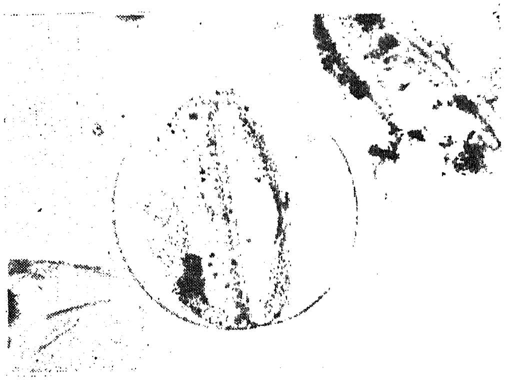


FIG. 1. Photomicrograph of *Hemidiscus hardmannianus* (Greville) Mann (× 100).

Similar heavy blooms of this diatom had been noticed earlier in 1954 in the Hooghly estuary at Uluberia and Kakdwip during the first and second week of June, and the last week of May respectively, when the river-water appeared unusually clear.[4] This again had coincided with a heavy catch of hilsa, in that its quantity brought to the Calcutta markets during the monsoon of that year was more than double the quantity brought in 1953.[5] It, therefore, appears reasonable to suggest that this diatom could possibly be used as an indicator species to the large-scale inland shoaling of hilsa.

Since the occurrence of this diatom bloom coupled with heavy landings of *hilsa* passed off quickly, detailed observations could not be made to ascertain the exact relationahip between the two. The concentration of hilsa might be due to the availability of optimal conditions at the edge of the diatom patches, or due to these patches acting as barriers to hilsa migration, as surmised by Savage and Wimpenny[1] in the case of the North Sea herring. The third possibility is that this diatom constitutes a preferred food item of hilsa, as diatoms are known to form one of the major components of food of this fish.[6] Unfortunately, due to delayed information, no specimen could be obtained for verifying this assumption. It would be worthwhile to make further studies on this phenomenon, to confirm the role of this diatom as an indicator species for hilsa.

Thanks are due to Dr. B. S. Bhimachar, Dr. V. G. Jhingran and Dr. Y. R. Tripathi for their kind encouragement and interest in this work.

Central Inland Fisheries
Research Institute,
Barrackpore, W. Bengal,
April 6, 1971.

H. P. C. SHETTY.
S. B. SAHA.

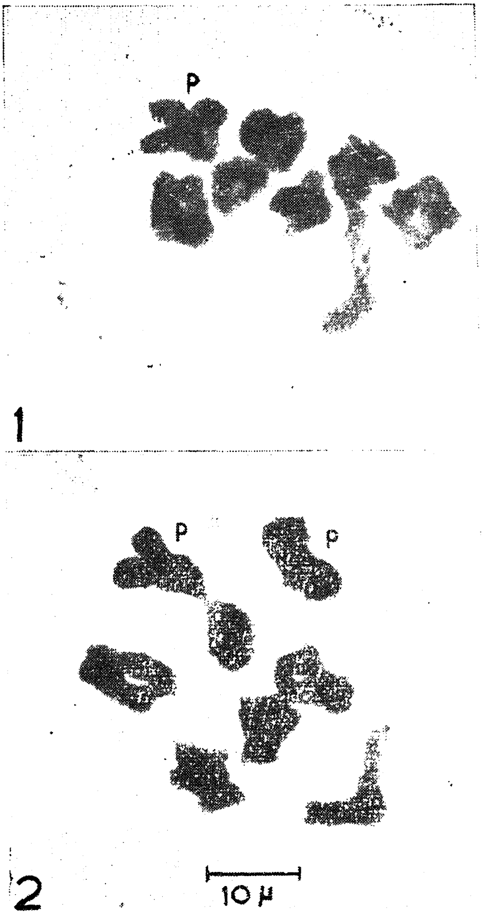
1. Savage, R. F. and Wimpenny, R. S., *Fishery Investigations*, Ser. II, 1934, **15** (1), 1.
2. Nair, R. V. and Subramanyan, R., *Curr. Sci.*, 1955, **24**, 41.
3. —, *Proc. of the World Scientific Meeting on the Biology of Sardines and Related Species*, 1960, **2**, 329.
4. Dutta, N., *Annual Report for the Year* 1954 (Unpublished).
5. Pillay, T. V. R., *Indian J. Fish.*, 1957, **4** (1), 150.
6. Pillay, S. R. and Rao, K. V., *Proc. Indo-Pacif. Fish. Coun.*, **10**th Session (Seoul), Sect. II, p. 37.

BREAKDOWN OF CHIASMA LOCALIZATION IN *ALLIUM CEPA*

A LOT of evidence exists to support the hypothesis that the genotype controls the form and behaviour of chromosomes.[1,2] Experiments on chiasma localization in *Allium cepa* and *Allium fistulosum* have been of great interest in this direction.[3–5] From various studies, a general agreement has emerged that proximal and distal localization of chiasmata in *A. fistulosum* and *A. cepa* respectively display a genetic control and the distal localization manifests itself as a dominant character in the F_1 offspring when the two species are crossed. The F_2 offspring, however, does not show convincingly a monohybrid Mendelian segregation. Instead, one observes varying degrees of randomly distributed chiasmata, besides the formation of bivalents with strict localization presumably, owing to recombination.

Allium cepa and *Allium fistulosum* are both outbreeders and show an adaptive compromise between chromosome behaviour and breeding system. Thus, the distal localization of chiasmata in *Allium cepa* acts as a restrictive practice for the genetic variability generated by the meiotic system and regulated by outbreeding. It also conserves combinations in the differential segments which act as super-genes. This sort of genetic system is well established in the cultivated onions which otherwise also display a wide range of variation in chromosome structure[6] and behaviour.[5]

During our studies on the genetic systems in *Allium*, we have found in a locally cultivated onion variety, "Punjab Selection", breakdown of distal localization of chiasmata and also errors of pairing and segregation in variable frequency in almost all the 14 plants comprising a random sample examined in 1969. Formation of the proximal chiasmata is perhaps the most unusual feature (Figs. 1, 2).



FIGS. 1–2. Metaphase-I of meiosis showing bivalenst with proximal (P) chiasmata.

Chiasma frequencies per cell at diplotene and metaphase-I varied from 18·16 to 21·28 and

13·6 to 15·3 respectively. This includes 15·4% to 29·8% proximal chiasmata formed at diplotene. In general, the proportion of the chiasmata formed in the proximal region of the chromosome arm tends to increase with an overall increase in the chiasma frequency unlike the median chiasmata which show an inverse relation. This is evidently owing to the breakdown of the conventional system with distal localization and a shift in the chiasma position primarily to the median region of the chromosome arm and then with an increase in the mean chiasma frequency to the proximal region as in the Truxaline grasshoppers.[7] Keeping in view the prime variables of meiosis,[8] the genotypic control which is typical of *Allium cepa* does not operate in the present material. This is similar to the formation of P-bivalents in *Allium nutans*[9] and rye[10] where the situation arises from homozygosity wrought by inbreeding. There is, however, no reason to believe that a similar causal mechanism operates in the present case where the cultivar is predominantly an outbreeder. The efforts of the earlier workers to incorporate the genome of *Allium fistulosum* into that of *Allium cepa* are, however, of great interest. We do not know the genesis of the present cultivar but it would not be surprising if it carries some blocks of *Allium fistulosum* gene material responsible for P-bivalent formation. In the cultivated onions, the bulb quality, however, is an important character. The selective gene combinations controlling bulb quality may also be responsible for the change in the meiotic character of the variety. Good development of the vegetative parts is understandable at the cost of fertility. The random chiasma formation, however, enhances recombination both in quantity and quality. But, with this system, the high level of hybridity is maintained at the cost of fertility. This is similar to rye situation where genotypic variation is brought about by the presence of B chromosomes which in turn lower the fertility by inducing univalence and a change in the pattern of chiasma distribution.[11] The low fertility in rye is, however, compensated by the seed weight. The variability potential achieved by this method is of great selective value as displayed by the European varieties of rye which have been selected for uniformity.[12]

Botany Department, S. VED BRAT.
Panjab University, BRIJINDER DHINGRA.
Chandigarh-14, *March* 17, 1971.

1. Rees, H., *Bot. Rev.*, 1961, **27**, 288.
2. Riley, R. and Law, C. N., *Advances in Genetics*, 1965, **13**, 57.
3. Maeda, T., *Jap. J. Genet.*, 1937, **13**, 146.
4. Levan, A., *Hereditas*, 1941, **27**, 244.
5. Emsweller, S. L. and Jones, H. A.. *Amer. J. Bot.*, 1945, **32**, 370.
6. Battaglia, E., *Caryologia*, 1963, **16**, 405.
7. Southern, D. I., *Chromosoma.*, 1967, **24**, 164.
8. Darlington, C. D., *Biol., Rev.*, 1940, **15**, 307.
9. Levan, A., In: Darlington, C. D., *Recent Advances in Cytology*, 1937.
10. Rees, H., *Heredity*, 1955, **9**, 93.
11. Jones, R. N. and Rees, H., *Ibid.*, 1967, **22**, 333.
12. Moss, J. P., *Chromosomes Today* (Eds. Darlington, C. D. and Lewis, K. R.), 1966, **1**, 15.

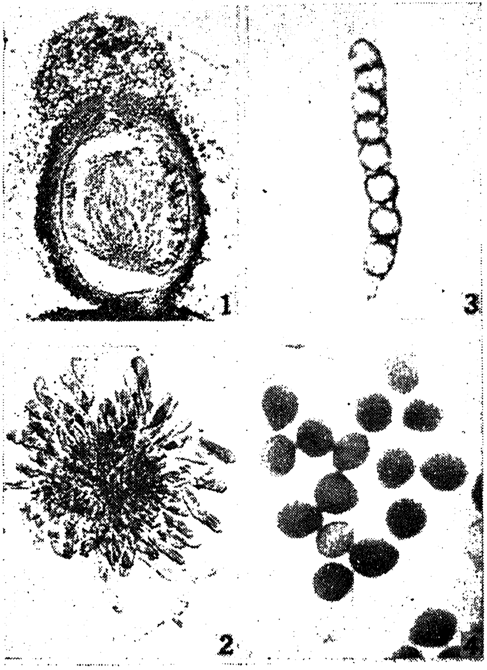
ACHAETOMIUM UNIAPICULATUM SPEC. NOV., A NEW SPECIES OF THE GENUS *ACHAETOMIUM*

THE genus *Achaetomium* includes four species all described by Rai *et al.*[3,4] So far, this genus which shows close resemblance to the members of Chaetomiaceae except that the perithecia lack hairy ornamentation, could not be adequately placed in any known family of Ascomycetes. Mukerji[2] suggested to place it in a new order Achaetomiales on the basis of loosely interwoven hyphae of the perithecial wall. However, in a recent paper Rai *et al.*[4] have shown that wall structure in *A. macrosporum* is similar to that found in the order Chaetomiales and have suggested that it should be placed in a new family 'Achaetomiaceae' of the order Chaetomiales rather than raising it to a new order only on the basis of the absence of hair from the perithecial wall.

The present paper deals with another new species of *Achaetomium*, *A. uniapiculatum* spec. nov. named after the ascospore characters that are apiculate only at one end. The new species differs from other known species also in the size and shape of perithecia, asci and ascospores. The new species shows close relationship to *A. macrosporum* but is clearly distinct from that in having larger perithecia, with ascospores that are almond-shaped and are apiculate only at one end. All colours mentioned in the text are after the Horticultural Colour Chart of the British Colour Council.[1]

Achaetomium uniapiculatum SPEC. NOV.
(Figs. 1-4)

Coloniae in agaro hordeaceo sat rapide Crescentes, mycelio Copioso leviter rosaceum. Ascocarpi superficiales, aggregati, raro dispersi, ostiolati, fixi substrato per hyphas rhizoideas, 250·0–288·0 μ × 216·0–250·0 μ. Asci octospori, fasciculati, Clavati, evanescentes, stipitati, apori, generatim, 76·8–88·0 μ × 10·0–14·4 μ. Ascosporae extrusae informa amygdolae et in uno termine apiculatae, irregulariter et binae dispositae in teneris ascis et postmodum uniseriatae adveniunt, griseo-brunneae, 16·0–16·8 μ × 11·6–12·8 μ.



FIGS. 1–4. *Achaetomium uniapiculatum* spec. nov. Fig. 1. Section of the mature ascocarp showing extrusion of ascospores, × 125. Fig. 2. Ascus fascicle from squash mount, × 140. Fig. 3. Ascus, × 510. Fig. 4. Ascospores, × 560.

Haec seiunctae fuerunt mense Junii, 1970, ab horti humo, in Indore, India, collecto. Dry cultura holotypus positus in herbario mycologico, sectione botanica, Universitatis lucknowensis, Lucknow, India.

Colonies on oatmeal agar moderately fast-growing, attaining a diameter of 7·0 cm in 4 days at 28° C, mycelium slightly pinkish with white margins, reverse brownish-black in the fruiting areas, reverse agar closely approaching 'Garnet-Brown (00918)'. Ascocarps usually in groups, rarely dispersed, measuring 250·0–288·0 μ × 216·0–250·0 μ. Asci clavate, shortly stipitate, aporate, deliquescing at early stage, unincrusted and fascicled, 8-spored commonly 76·8–88·0 μ × 10·0–14·4 μ. Ascospores arranged irregularly biseriately in younger asci, later on becoming uniseriate, greyish-brown, 16·0–16·8 μ × 11·6–12·8 μ, almond-shaped, apiculate at one end with a single pore.

Isolated in June 1970, from garden soil (pH 7·0) collected from Indore, India. Type in the form of dried culture deposited in the Department of Botany, Lucknow University, Lucknow.

The authors are grateful to Mother Cyrill for the Latin diagnosis and to the U.S. PL 480 authorities for the financial assistance.

Dept. of Botany, J. N. RAI.
Lucknow University, H. J. CHOWDHERY.
Lucknow, *April* 16, 1971.

---

1. *Horticultural Colour Chart*, Issued by the British Colour Council in collaboration with the Royal Horticultural Society, Henry Stone & Son Ltd., Banbury, Great Britain, 1938.
2. Mukerji, K. G., *Proc. Natl. Inst. Sci., India*, 1968, **34 B**, 288
3. Rai, J. N., Tewari, J. P. and Mukerji, K. G., *Can. J. Bot.*, 1964, **42**, 693.
4. —, Wadhwani, K. and Tewari, J. P., *Indian Phytopath.*, **1969**, **23 (1)**, **54**.

HETEROTIC RESPONSE FOR PER CENT GRAIN PROTEIN AND PELSHANKY VALUE IN BREAD WHEAT

THE discovery of cytoplasmic-genic male sterility[4,9] and its fertility restoring mechanism[6] in bread wheat (*Triticum aestivum* L. em. Thell.) stimulated the interest of plant breeders towards the commercial exploitation of hybrid vigour in this crop. The manifestation of heterosis for grain yield in wheat has been reported by several workers.[1,3,7,8] However, limited attention has so far been paid towards the study of heterotic response for the quality characters. The success of hybrid wheat would also depend upon the quality of its grain, as it is an important source of human nutrition. In the present investigation, the extent of heterosis for per cent grain protein and pelshanky value has been observed in 8 × 8 diallel crosses.

The experimental material for this investigation comprised of eight wheat cultivars (S 210, S 386, Kalyan Sona, Safed Lerma, S 410, C 273, Chhoti Lerma and Sonora 64) and all possible 28 one-way crosses involving these cultivars. The experiment was sown in a randomized block design with three replications. The per cent grain protein was determined according to McKenzie and Wallace[5] and the methods of Cutler and Worzella[2] were utilized for determining pelshanky value in minutes on plot basis for the first two replications.

Parental and F_1 array means and mean increase/decrease over the mid-parent for each array for per cent garin protein and pelshanky

TABLE I

Parental and F_1 array means and heterotic response for per cent grain protein and pelshanky value

Array	Per cent grain protein: Parents	F_1	Mean increase/decrease over mp*(%)	Pelshanky value (Min.): Parents	F_1	Mean increase/decrease over mp*(%)
S 210 ..	16·4	15·6	− 2·9	206·5	168·1	−5478·9
S 386 ..	15·0	16·5	147·1	204·5	170·3	−3035·4
Kalyan Sona	13·4	14·5	13·6	125·0	159·5	7·0
Safed Lerma	13·8	15·0	43·7	131·5	145·1	−1706·7
S 410 ..	15·9	15·2	−27·7	255·0	184·6	−3056·9
C 273 ..	15·7	15·9	49·1	206·0	174·9	−1921·1
Chhoti Lerma	15·3	15·3	− 1·6	125·0	123·6	−3585·9
Sonora 64	15·7	15·4	2·0	228·5	185·1	−2578·7
S.E. ..	0·2	0·3	0·3	7·1	7·3	8·7

* mp,—mid-parent

value are set out in Table I. This investigation revealed that most of the array of crosses exhibited considerable heterosis for per cent grain protein, the range of the heterotic response over the mid-parent being from — 27·7% to 147·1%. However, for pelshanky value, such range was from — 5478·9% to 7·0%. The crosses involving cultivar S 386 exhibited maximum heterosis for grain protein, whereas cultivars S 210, S 386 and C 273 seem to be good for producing wheat hybrids with medium pelshanky value, which is an ideal characteristic for *chapati* making. These studies, therefore, showed promise of developing high quality wheat hybrids in case of commercial exploitation of hybrid vigour in this self-pollinating species.

Dept. of Plant Breeding, K. S. BAINS.
Punjab Agric. University, K. S. GILL.
Ludhiana, *April* 6, 1971. K. L. SEHGAL.

---

1. Engledow, M. A. and Pal, B. P., *J. Agric. Sci.*, 1934, **24**, 390.
2. Cutler, G. H. and Worzella, W. H., *Amer. J. Agron.*, 1931, **23**, 1000.
3. Gandhi, S. M., Uma, M. T., Bhargava, P. D. and Bhatnagar M. P., *Ind. J. Genet.*, 1961, **21**, 1.
4. Kihara, H., *Cytologia*, 1951, **16**, 177.
5. Mckenzie, H. A. and Wallace H. S., *Aust. J. Chem.*, 1954, **1**, 55.
6. Schmidt J. W., Johnson, V. A. and Mann, S. S., *Nebr. Exp Sta.*, 1962, **9** (3), 9
7. Sikka, S. M., Jain K. B. L. and Parmar, K. S., *Ind. J. Genet.*, 1959, **19**, 150.
8. Singh, K. B. and Dawa, T., *J. Res., Ludhiana*, 1968, **5**, 41.
9. Wilson, J. A. and Ross, W. M., *Crop Sci.*, 1961, **1**, 191.

PHENOLIC CONSTITUENTS IN WHEAT GRAINS

IN view of the reported involvement of phenols in whole-meal dough darkening,[1,2] browning of *chapatties*[3,4] and alteration of various enzymatic processes,[5,6] grains of some of the tall and dwarf wheats were analysed for their free and glycosidic phenolic constituents.

Grains of tall wheat varieties, *viz.*, *C 273*, *C 306*, *C 591*, *NP 830* and *NP 880* and dwarf wheats, *viz.*, *Lerma rojo*, *Sonalika*, *Sonara 64*, *Sharbati Sonora* and *Kalyansona* were ground in Labconco Mill. Whole-meal was extracted in boiling 80% ethanol for 1 hr. Free and acid hydrolysable phenols were determined by the methods of Swain *et al.*[7] and Ibrahim and Tower[8] using Folin-Ciocalteau reagent and expressed as mg/100 gm wheat-meal. Milling fractions were obtained using Seaborg and Barmore's method.[9] *Chapatties* were prepared as described elsewhere.[4]

Total phenolics varied from 83·10 in the variety *C 306* to 166·20 in *Sonalika*. Analysis of free phenolics revealed that the amount varied from 53·20 to 93·20. Acid hydrolysable phenolics, which reflect the glycosidic forms,[8] were consistently lower than the free phenolics. Varieties *C 306* and *Sharbati Sonora* had low amount of glycosidic phenols (Table I).

TABLE I

Phenolic constituents in grains of different wheat varieties

(mg/100 gm whole-meal)

Variety	Free phenols	Acid-hydrolysable phenols	Total phenols
Lerma rojo ..	90·00	60·00	150·00
Sonalika ..	80·00	86·20	166·20
Sonora 64 ..	86·50	63·50	150·00
Sharbati Sonora ..	93·20	31·80	125·00
Kalyansona ..	73·20	52·80	125·00
C 273 ..	80·00	45·00	125·00
C 306 ..	63·20	19·90	83·10
C 591 ..	93·20	48·00	142·10
NP 830 ..	53·20	46·80	100·00
NP 880 ..	60·00	40·00	100·00

Analysis of total phenolics in the milling fractions of variety *Sonalika* showed that in bran the values varied from 200 to 240 in middlings (shorts), from 230 to 260, and in flour from 130 to 150.

Examination of the wheat grains of varieties *Kalyansona* and *Sonalika* grown at two fertility levels, *viz.*, N_0 and N_{200} (kg/hec) showed that there was an increase in the total phenolics with fertility in both the varieties. The increase was reflected in both the fractions in variety *Kalyansona* and in free phenolics fraction in variety *Sonalika* (Table II).

TABLE II
Effect of nitrogen fertilization on phenolics of wheat grains

Variety	Fertility level (kgN/hect)	Free phenols	Acid-hydrolysable phenols	Total phenols
		(mg/100	gm whole-meal)	
Kalyansona	N_0	73·20	43·00	111·20
	N_{200}	93·20	64·90	158·70
Sonalika	N_0	80·00	86·20	166·20
	N_{200}	113·20	86·80	200·00

Phenolic constituents in the end product, namely, *chapatties*, the form in which grains are mostly consumed in India, showed that the amount varied from 66·2 mg to 91·2 mg. The loss in phenols was reflected in both free and acid-hydrolysable forms.

TABLE III
Phenolics in chapatties
(mg/100 gm; calculated to 10% moisture basis).

Variety	Free phenols	Acid-hydrolysable phenols	Total phenols
Sonora 64 ..	53·20	38·00	91·20
Sonalika ..	46·50	36·60	83·10
C 306 ..	43·20	23·00	66·20
C 591 ..	45·00	38·10	83·10

From the above observations, it is obvious that the varieties differ markedly in their phenol content and its value showed increase with higher nitrogen fertility levels. Bran and shorts have higher phenolics than the flour (endosperm). Further studies on the isolation, identification of the various phenols and their possible role in affecting enzymatic activity[10-12] are in progress.

The authors wish to thank Dr. H. K. Jain, Head of the Division of Genetics, Indian Agricultural Research Institute, for encouragement and providing the facilities.

Cereal Laboratory, Y. P. ABROL.
Division of Genetics, D. C. UPRETY.
Indian Agric. Res. Inst.,
New Delhi-12, *March* 3, 1971.

---

1. Abrol, Y. P., *Proc. 5th World Congress on Cereals and Bread.*, Dresden. Germany, 1970.
2. — and Uprety, D. C., *Curr. Sci.*, 1970, **39**, **431**.
3. —, — and Ram, A., *Jour. Food Sci. & Tech.*, March 1971.
4. —, — and Tikko, Swaran, *First Asian Congress of Nutrition*, Research Communications, Hyderabad, 1971, p. 40.
5. Anderson, J. W., *Phytochemistry*, 1968, **7**, 1973.
6. Milic, B., Stojanovic, S., Vucurevic, N. and Turcic, M., *Jour. Sci. Food and Agri.*, 1968, **19**, 108.
7. Swain, T. and Hillis, W. E., *Ibid.*, 1959, **10**, **63**.
8. Ibrahim, R. K. and Towers, G. H. N., *Arch. Biochem. and Biophys.*, 1960, **87**, 125.
9. Seaborg, E. F. and Barmore, M. A., *Cereal Chemistry*, 1957, **34**, 289.
10. Honold, G. R. and Stahman, M. A., *Ibid.*, 1968, **45**, 99.
11. Krishnan, P. S., Viswanathan, P. N. and Mattoo, R. L., *Jour. Sci. & Ind. Res.*, 1969, **28**, 93.
12. Guenzi, W. D. and McCalla, T. M., *Agronomy Jour.*, 1966, **58**, 303.

A STORAGE ROT OF TOMATO FRUITS (*LYCOPERSICON ESCULENTUM* MILL.) CAUSED BY *GEOTRICHUM CANDIDUM* LINK EX PERS.

DURING local survey of the diseases of some of the fruits and vegetables, which occur during transit and storage, a post-harvest rot of tomato fruits was observed. It was incited by *G. candidum*. A large number of the fruits were destroyed by the fungus.

The usual technique was followed for isolating the pathogen from the diseased fruits. Its pathogenicity was confirmed as the Koch's postulates were fully satisfied.

Under natural conditions, the infection was observed to occur through the cracks of the skin on the ripe fruits. The cracks on the skin started mostly from the stem end of the fruits. Artificially, the infection was induced only after causing skin injury of the mature fruits or through any other opening. The cracks invariably increased with the progress of the disease in the fruits. It was further observed that the pathogen could infect only ripe tomatoes as inoculation of unripe fruits failed to produce the disease.

The infection which started as a small soft colourless area was not confined to any particular region of the fruit. In general, the entire fruit got infected in 10–12 days. The fruits turned soft and pulpy and skin became loose and wrinkled. The mycelium and conidia were observed on the diseased surface. A juice with unpleasant odour was emitted from the diseased fruits. It was estimated that the intensity of the disease during storage and transit varied from 10% to 40% in different months.

The stock cultures of the pathogen were maintained on potato-dextrose agar medium. In culture, the mycelium was powdery-white, prostrate, profusely branched, septate, 2·84–5·68 μ in thickness. Conidia were hyaline as well as powdery-white, 1-celled, short, cylindrical with truncate ends, formed by segmentation of the hyphae. They measured 2·84–14·20 μ × 2·84–7·10 μ (*vide* Fig. 1), In order to determine the range of parasitism of the organism, it was inoculated on different fruits. It was observed that fruits of banana (*Musa paradisiaca* L.), apple (*Malus sylvestris* Mill.) and lemon [*Citrus aurantifolia* (Christm.) Swingle] were susceptible to disease. It, however, failed to parasitise guava (*Psidium guajava* L.), amla (*Phyllanthus emblica* L.), young and unripe tomatoes (*Lycopersicon esculentum* Mill.) and brinjal (*Solanum melongena* L.).

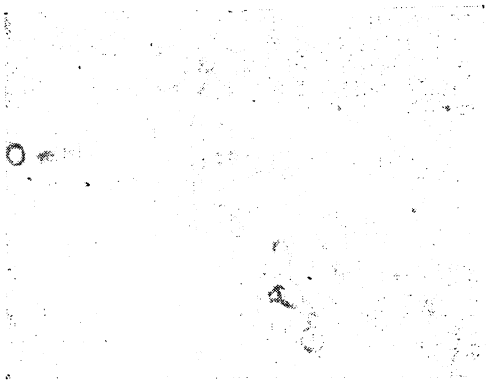


FIG. 1

This disease has not been reported from India so far, even though it caused severe damage during November 1969 to March 1971.

The identity of the fungus has been confirmed by CMI, Kew, England (No. 151735).

The authors are thankful to the C.S.I.R. for financial assistance, and to Miss Stockdale and the Director, Commonwealth Mycological Institute, Kew, Surrey, England, for very kindly identifying the organism.

Dept. of Botany, JAMALUDDIN.
Univ. of Allahabad, M. P. TANDON.
Allahabad, *March* 9, 1971. R. N. TANDON.

VERTICILLIUM DAHLIAE WILT OF COTTON

Verticillium wilts have a world-wide distribution involving a wide host range. A *Verticillium* wilt was recently reported from Coimbatore and its environments on cotton (*Gossypium hirsutum*) and brinjal (*Solanum melongea*), prevalent during the cooler months.[1] The pathogen, however, had not been isolated from cotton.

Field-wilted cotton plants showing the typical *Verticillium* wilt syndrome were collected during January 1971, and isolations made from symptomatic portions yielded a species of *Verticillium* producing the characteristic verticillate conidiophores. During continued growth of this fungus in culture, dark resting structures, the typical microsclerotia,[2] were formed. Based on the development and structure of these microsclerotia this isolate was identified as *Verticillium dahliae* Kleb. Using a pure culture of the pathogen, Koch's postulates were successfully demonstrated on *G. hirsutum*. This appears to be the first authentic record of this disease in India.

We thank Professor T. S. Sadasivan for facilities kindly provided.

University Botany Lab., T. T. PANDIAN.
Madras-5. IVOR ISAAC.*

---

*Visiting scientist from the University College, Swansea, U.K.

1. Natarajan, M. K., Sivaprakasam, K. and Ramakrishnan, K., *Madras agric. J.*, 1968, **55**, 455.
2. Isaac, I., *A. Rev. Phytopath.*. 1967, **5**, 201.

EFFECT OF TRYPTOPHANE ON SYMBIOSIS BETWEEN CLUSTER CLOVER AND *RHIZOBIUM TRIFOLII*

TRYPTOPHANE is a component of root exudates of certain legumes.[3,4] Rhizobia are known to convert the amino-acid to indoleacetic acid which has been implicated in the deformation of root hairs of legumes, a necessary prerequisite for infection by *Rhizobium*.[2] The present investigation has been carried out to study the effects of different levels of tryptophane on the symbiosis between cluster clover (*Trifolium glomeratum*) and an efficient strain of *Rhizobium trifolii* under bacteriologically-controlled conditions.

Seeds were surface-sterilized with sulphuric acid for 10 min, washed with several changes of sterile water and sown on Jensen's nitrogen-free mineral salts agar slopes[1] in 25 × 200 mm test-tubes (one seed per tube). Upon germination, the seedlings were fed with 5 ml aliquots of $\frac{1}{4}$ strength Jensen's nitrogen-free solution (pH 7·0) inoculated with a suspension of *Rhizobium*. L-tryptophane was incorporated in the liquid medium so as to obtain different levels of the amino-acid ranging from 0·025 μg to 2·5 mg per 5·0 ml of liquid medium in each tube. Control plants did not receive the amino-acid but had only the nutrient solution inoculated with the bacterium. Twenty replicate tubes were maintained for each treatment. The plants were kept in normal sunlight in a glass house where temperature did not exceed

25° C. The date on which the initial nodules appeared was noted; after 60 days, data were collected on the number of nodules, lateral roots and leaves, and the dry weight of plants (Table I).

TABLE I

The influence of different amounts of tryptophane on the symbiosis between cluster clover and* R. trifolii *(mean of 20 replicates)*

Sr. No.	Tryptophane μg/tube	Initial nodulation (days)	At 60 days Nodules	Leaves	Laterals	Dry weight (mg)
1.	0·000 (control)	11·0	10·20	4·0	2·3	2·86
2.	0·025	8·3	14·10	4·5	3·1	3·63
3.	0·050	9·8	9·60	4·4	3·1	3·62
4.	0·250	8·7	11·50	4·3	2·8	3·46
5.	0·500	10·1	13·10	4·6	3·5	3·46
6.	1·250	10·9	9·10	4·3	2·3	3·22
7.	2·500	10·4	10·30	6·2	5·4	8·73
8.	3·750	10·5	17·20	5·8	9·2	9·04
9.	5·000	10·4	13·10	6·0	7·0	8·05
10.	50·000	13·5	6·45	4·3	10·2	6·41
11.	250·000	12·5	5·30	4·6	16·1	7·52
12.	500·000	18·3	6·20	3·9	10·8	13·18

* Doses of 1 mg and 2·5 mg/tube inhibitory to nodulation and plant growth (stunted in appearance with stout lateral roots).

Plants receiving tryptophane upto 0·250 μg/per tube nodulated earlier than those which did not receive the amino-acid (control) indicating the optimum levels of the compound necessary for hastening the process of nodulation. On the other hand, plants receiving tryptophane beyond 50·0 μg per tube showed tendency towards delayed nodulation. No definite trend could be made out with regard to the number of leaves and nodules at the end of 60 days except that levels of tryptophane beyond 50 μg per tube decreased the number of nodules. Doses of 1 mg and 2·5 mg of the amino-acid per tube proved inhibitory to nodulation as well as plant growth. In general, a tendency towards an increase in the number of lateral roots was apparent in plants having tryptophane from 2·5 μg per tube and onwards. In a similar way, a general increase in the dry weight of plants was also noticeable from 2·5 μg onwards which may partially be attributed to the observed increase in the formation of lateral roots.

Division of Microbiology, S. P. MAGU.
Indian Agric. Res. Inst., N. S. SUBBA RAO.
New Delhi-12, India,
March 24, 1971.

---

1. Jensen, H. L., *Proc. Linn. Soc. N.S.W.*, 1942, **51**, 205.
2. Kefford, N. P., Brockwell, J. and Zwar, J. A., *Aust. J. Biol. Sci.*, 1960, **13**, 456.
3. Rovira, A, D., *Plant and Soil*, 1956, **7**, 178.
4. Subba Rao, N. S. and Vasantha, P., *Can, J. Bot.*, 1965, **43**, 1189.

REVIEWS AND NOTICES OF BOOKS

Solar Eclipses and the Ionosphere. Edited by M. Anastassiades. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011), 1970. Pp. xiv + 309. Price $ 18.50.

This publication contains the Proceedings of a NATO Advanced Studies Institute on "Solar Eclipses and the Ionosphere", held in Lagonissi, Greece, May 26–June 4, 1969. It was an international symposium whose participants came from many countries, especially from those whose eclipse teams took part in ionospheric studies during the annular solar eclipse of May 20, 1966, near and around Lagonissi which lay along the central path of the eclipse.

It may be mentioned that the last international symposium on "Solar Eclipses and the Ionosphere" was held in London in 1955. The report of that meeting, edited by Benyon and Brown, came out as a Pergamon Press publication under that title in 1956. It presented the status of the subject as it existed then. The intervening 15 years has seen the advent of the space age, and many new techniques including rocket experiments and satellite tracking are now available for making detailed studies of this ionised envelope of the earth, its different layers, the chemistry and physics of their plasmic contents. The ionosphere as a whole acts as a photocell sensitive to changes in solar flux, and comparative data obtained on its study during eclipse conditions and full-sun conditions are valuable not only to get information about the ionosphere itself, but also about regions of the sun responsible for the ionising radiations. When the eclipse is annular, the coronal part of the sun plays a more significant role in the ionospheric processes.

The book presents the latest knowledge on the subject as revealed by various techniques used by the observation groups such as satellite, riometer, radio-astronomical, ionosondes network, partial-reflection technique measurements, and NASA rockets.

It will be a useful reference source to research workers concerned with ionospheric studies, and particularly to such investigators during solar eclipses.

The nineteen studies reported are arranged under the following main heads: Theoretical Aspects; D-Region Chemistry; Solar Radiation and Layer Theory; Radio-Astronomical Observations; Eclipse Studies by Rocket, Satellite and Partial-Reflection Studies; and Ionospheric Eclipse Effects. A. S. G.

Far-Infrared Properties of Solids. Edited by S. S. Mitra and S. Nudelman. (Plenum Publishing Corporation, New York), 1970. Pp. viii + 606.

This publication which is a volume in the Optical Physics and Engineering Series, edited by William L. Wolfe, contains the Proceedings of a NATO Advanced Study Institute, held in Delft, Netherlands, August 5-23, 1968.

The subject-matter covers important areas of current research relating far-infrared radiation to poperties of solids. It includes theoretical as well as experimental considerations. The authors who lectured at the Institute have carefully organised the contents of their lectures and presented them in a manner to suit the requirements of graduate students and research workers in this field of optical physics.

The first six chapters present material concerned principally with experimental considerations, such as interferometric spectroscopy in the far-infrared, far-infrared sources and detectors, developments in laser Raman spectroscopy techniques, etc. These chapters also provide introductory material for the remaining chapters which deal in depth with several areas of research such as: Far-infrared absorption in superconductors, and in ordered magnetic systems; far-infrared dispersion and the Raman spectra of ferroelectric crystals; lattice vibrations of solid solutions, and lattice absorption in the very far-infrared, low frequency vibrations of polymers; high pressure research in the far-infrared; and far-infrared electronic transitions in rare earth ions.

Important reference material is included in each chapter. The book provides up-to-date information to workers in this branch of far-infrared research. A. S. G.

Annual Review of Phytopathology (Vol. 8). (Annual Reviews, Inc., 4139, El Camino Way, Palo Alto, California 94306, U.S.A.), 1970. Pp. vii + 480. Price U.S.A. $ 10.00; Foreign $ 10.50.

This series on phytopathology which has entered its ninth volume this year has been helping plant pathologists to keep themselves abreast of current researches in their subject. The reviews are critical and references exhaustive. One finds in these volumes a continuity of presentation of the status of the subject. Important areas of research are covered in each volume, and significant advances made in each area stressed.

In addition, each volume contains informative articles of wider interest which may appeal to the general scientific reader as well. In this connection, the following titles in Volume 8 under review may be mentioned. "The History of Plant Pathology in Australia"; "Catastrophic Plant Diseases"; "Gene Centers of Plants as Sources of Disease Resistance"; "Use of Weather Information in the Prediction of Plant Disease Epiphytotics"; "Phytopathological Organizations of the World". Of course, there is always the Prefatory Chapter which commands the immediate attention and admiration of the reader. In the present volume, this contribution is from Dr. F. C. Bawden, Director, Rothamsted Experimental Station, entitled, "Musings of an Erstwhile Plant Pathologist". It is autobiographical, and so, extremely interesting and instructive.

Some of the other review articles in this volume are: Variation in *Xanthomonas malvacearum* and Its Relation to Control Biology and Taxonomy of the Dwarf Mistletoes; Ultrastructural Aspects of Woody Tissue Disintegration; Biophysics and Biochemistry of the Vascular Wilt Syndrome; Mechanism of Action of Antifungal Antibiotics; and Plant Chemotherapy with Natural Products. A. S. G.

Plenum Books on Mossbauer Spectroscopy. (Plenum Publishing Corporation, 114, Fifth Avenue, New York, N.Y. 10011, U.S.A.).

1. **Mossbauer Effect, 1969. Data Index.** Edited by J. G. Stevens and V. E. Stevens. Pp. xxxvi + 281. Price $ 24.00.

2. Mossbauer Effect Methodology (Vol. 6). Edited by I. J. Gruverman. Pp. viii + 237. Price $ 19.50.
3. An Introduction to Mossbauer Spectroscopy. Edited by L. May. Pp. x + 203. Price $ 15.00.

To users of its predecessor, Mossbauer Effect Data Index 1958-65, the present volume needs no introduction. It is a continuation in the same format, but the collected data is confined to articles which appeared during the year 1969 only. Workers in Mossbauer spectroscopy would very much like the gap for 1966-68 to be filled to have a complete reference source in this growing area of research.

The *Data Index* tabulates the source and absorber host materials and temperatures, line width, dip, chemical shift, and quadrupole splitting. The shape of the spectrum is reported in coded form.

Mossbauer Effect Methodology is the sixth volume in this series and contains the Proceedings of the Sixth Symposium on the subject held in New York City, January 25, 1970. Particular mention should be made to four communications on Mossbauer investigations of Lunar Samples brought by the Apollo 11 mission.

An Introduction to Mossbauer Spectroscopy is a much-needed single book on the subject for use by workers in Mossbauer spectroscopy in industrial, academic and government laboratories. The chapters are based on lectures given at the various Institutes from 1967-69 by authors who are actively engaged in this research. It is an extremely suitable text to introduce the subject to graduate students and research workers.

A. S. G.

ANNOUNCEMENTS

Award of Research Degrees

The M.S. University of Baroda has awarded the Ph.D. degree in Chemistry to Shri Rajnikant Nagindas Kapadia.

Osmania University, Hyderabad, has awarded the Ph.D. degree in Botany to Kumari B. K. Vaidehi.

Utkal University has awarded the Ph.D. degree in Chemistry to Shri Ashutosh Nayak.

First International Prize "Fundacion Viviana Luckhaus" 1972

The Fundacion Viviana Luckhaus has instituted the "International Prize Fundacion Viviana Luckhaus, 1972".

The Prize is intended to honour a report of original research related to blood platelets (morphology, physiology, biochemistry, pathology, etc.) and/or their relationship to thrombosis and blood vessels, and to promote communication and interchange between research workers in different parts of the world.

For further information and rules for the 1972 contest, apply to Dr. Edgardo S. Sack, Fundacion Viviana Luckhaus, Hospital Juan A. Fernandez, Cervino 3356, Buenos Aires, Argentina.

Second National Congress on Diabetes

The Poona Branch of the Diabetes Association of India is organising the Second National Congress on Diabetes, on 3rd, 4th and 5th December 1971.

The Congress which is held once every three years, is open to all workers in the field of Diabetes. The last date for sending the scientific papers is 10th October 1971. All correspondence regarding the Congress may kindly be addressed to: Dr. V. S. Prayag, Organising Secretary, Second National Congress on Diabetes, Department of Medicine, B.J. Medical College, Poona.

Books Received

Behavior and Environment—The Use of Space by Animals and Man. Edited by A. H. Esser. (Plenum Pub. Corpn., 114, Fifth Avenue, New York, N.Y. 10011), 1971. Pp. xvi + 244. Price $ 17.50.

Applied Solid-State Physics. Edited by W. Low and M. Schieber. (Plenum Pub. Corpn.), 1971. Pp. vii + 244. Price $ 13.50.

Analytical Calorimetry (Vol. 2). By R. S. Porter and J. F. Johnson. (Plenum Pub. Corpn.), 1970. Pp. xvi + 460. Price $ 19.50.

Advances in X-Ray Analysis. Edited by C. S. Barrett, J. B. Newkirk and C. O. Ruud. (Plenum Pub. Corpn.), 1971. Pp. ix + 500. Price $ 25.00.

Block polymers. Edited by S. L. Aggarwal. (Plenum Pub. Corpn.), 1970. Pp. x + 339. Price $ 16.00.

Physics of Hot Plasmas. Edited by B. J. Rye and J. C. Taylor. (Plenum Pub. Corpn.), 1970. Pp. xv + 455. Price $ 35.00.

Progress in Mathematics (Vol. 9)—*Algebra and Geometry.* (Plenum Pub. Corpn.), 1971. Pp. ix + 253. Price $ 19.50.

Progress in Mathematics (Vol. 8)—*Mathematical Analysis.* (Plenum Pub. Corpn.), 1971. Pp. viii + 215. Price $ 15.00.

2936-71. **Published by S. R. S. Sastry, Manager, Current Science Association, Bangalore-6, and Printed by V. J. F. Jesudason, at The Bangalore Press, Bangalore-18.**

BD-20/70

CURIOSITY IS COMMON TO A CHILD AND AN ANALYST

Curiosity about our laboratory reagents and their varied grades will pay you handsome dividends in reliability and price. For the best and the latest in Laboratory Reagents, look for SARABHAI M. CHEMICALS label.

SARABHAI M. CHEMICALS PVT LTD

POST BOX NO. 80, WADI WADI, BARODA

NORMAL CO-ORDINATE ANALYSIS OF N-METHYLTHIOPROPIONAMIDE

K. VENKATA RAMIAH

Department of Physics, Osmania University, Post-Graduate Centre, Warangal-1 (A.P.)

AND

C. A. INDIRA CHARY

Dept. of Physics, University College for Women, Osmania University, Hyderabad-7

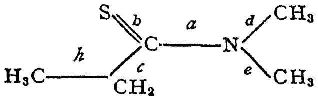
INTRODUCTION

NORMAL co-ordinate treatment of primary, secondary and tertiary amides has been carried out by Suzuki,[1,2] Miyazawa *et al.*[3] and Venkata Chalapathi and Venkata Ramiah[4] to estimate the magnitude of the coupling between various skeletal frequencies and clarify the nature of the amide I, the amide II and the amide III absorption bands. A significant result that has emerged out of these investigations is that a band in the region of 1300 cm^{-1} in primary amides is essentially due to C-N stretch while in secondary amides, the bands in the region of 1550 cm^{-1} and 1300 cm^{-1} are shown to arise as due to the combined contribution of the δ (NH) and ν (C-N) vibrations. On the other hand, band contour studies and studies of normal vibrations of tertiary amides have conclusively shown that the band in the region of 1500 cm^{-1} in these molecules is essentially due to the C-N stretch.

The study of the vibrational spectra and normal vibrations of primary and secondary thioamides has been made by Suzuki.[5,6] The authors[7] have carried out the normal co-ordinate treatment of tertiary thioamides like N, N-dimethylthioformamide and N, N-dimethylthioacetamide. An important result that has been obtained in these studies is the dfference in the value of the C=S stretching frequency in various thioamides because of the difference in the magnitude of the coupling between this mode of vibration and the remaining in-plane modes of vibration. Another salient feature of the experimental observation is that the C-N stretching frequency in tertiary thioamides is higher than that of the same frequency in the corresponding tertiary amides.

NORMAL CO-ORDINATE TREATMENT

In this paper, we report the normal co-ordinate analysis of N, N-dimethylthiopropionamide. We have treated this molecule as a seven body problem taking CH_3 and CH_2 as point masses. The structure of N, N-dimethylthiopropionamide is shown below:



The molecule belongs to the point group Cs and the selection rules indicate that the fifteen fundamental frequencies which are classified into 11 in-plane (A′) and 4 out of plane (A″) vibrations are active both in the infrared and the Raman spectra. The orthonormalised set of symmetry co-ordinates for the in-plane vibrations of the molecule are given in Table I.

TABLE I

Symmetry co-ordinates	Vibrational mode
$R_1 = \frac{1}{\sqrt{2}}(\Delta d - \Delta e)$	$\nu_{as}\left(\mathrm{N}\begin{matrix}\diagup\mathrm{CH_3}\\ \diagdown\mathrm{CH_3}\end{matrix}\right)$
$R_2 = \frac{1}{\sqrt{2}}(\Delta d + \Delta e)$	$\nu_{s}\left(\mathrm{N}\begin{matrix}\diagup\mathrm{CH_3}\\ \diagdown\mathrm{CH_3}\end{matrix}\right)$
$R_3 = \Delta C$	ν (C—CH_2)
$R_4 = \Delta a$	ν (C—N)
$R_5 = \Delta b$	ν (C=S)
$R_6 = \Delta h$	ν (C—CH_3)
$R_7 = \frac{1}{\sqrt{6}}(2\Delta de - \Delta ad - \Delta ae)$	$\delta_{as}\left(\mathrm{N}\begin{matrix}\diagup\mathrm{CH_3}\\ \diagdown\mathrm{CH_3}\end{matrix}\right)$
$R_8 = \frac{1}{\sqrt{2}}(\Delta ad - \Delta ae)$	$\delta_{s}\left(\mathrm{N}\begin{matrix}\diagup\mathrm{CH_3}\\ \diagdown\mathrm{CH_3}\end{matrix}\right)$
$R_9 = \frac{1}{\sqrt{6}}(2\Delta ab - \Delta ac - \Delta bc)$	δ (S=C—N)
$R_{10} = \frac{1}{\sqrt{2}}(\Delta ac - \Delta bc)$	γ (C—CH_2)
$R_{11} = \Delta ch$	γ (C—CH_3)

Using the general quadratic force field, the elements of the F-matrix are obtained in the usual way. The elements of the G-matrix have been computed from the general method given by Shimanouchi[8] for such related molecules, The structure parameters used in these calculations are:

$\gamma\ (C{=}S) = 1{\cdot}713$ Å,
$\gamma\ (C{-}N) = 1{\cdot}294$ Å,
$\gamma\ (C{-}CH_3) = \gamma\ (C{-}CH_2) = 1{\cdot}55$ Å, and
$\gamma\ (N{-}CH_3) = 1{\cdot}47$ Å.

All the bond angles are assumed as 120°.

The calculations of normal vibrations were made by the method of Wilson. For solving the secular determinant which has the dimensionality of 11×11 and computing the polynomial coefficients, a program written in Fortran language on the basis of modified Danielewsky's method for Model 2, IBM, 1620 digital computer was used. General program of IBM 1620 was used to extract the roots of the polynomial.

The force constants proposed in related molecules like N, N-dimethylthioformamide and N, N-dimethylthioacetamide[7] were transferred and slight alterations were made in a few constants to obtain an agreement between the observed and the calculated frequencies. The final set of force constants of N, N-dimethylthiopropionamide are given in Table II. The observed and calculated frequencies are given in Table III.

TABLE II

Type of force constants	Value of the force constants	Type of force constants	Value of the force constants
Bond stretching	$f_d = f_e = 5{\cdot}0$ $f_c = 4{\cdot}0$ $f_b = 4{\cdot}0$ $f_a = 6{\cdot}6$ $f_h = 4{\cdot}0$	Bond/Bond	$f_c^{\,a} = 1{\cdot}0$ $f_a^{\,b} = 0{\cdot}3$ $f_b^{\,c} = 1{\cdot}2$ $f_c^{\,a} = 1{\cdot}2$ $f_c^{\,h} = 0{\cdot}4$
Bond bending	$f_{ab} = 0{\cdot}7$ $f_{bc} = 0{\cdot}7$ $f_{ca} = 0{\cdot}8$ $f_{ad} = f_{ae} = 1{\cdot}1$ $f_{ed} = 1{\cdot}0$ $f_{ch} = 1{\cdot}0$	Bond/Angle	$f_c^{\,ca} = 0{\cdot}9$ $f_c^{\,bc} = 0{\cdot}9$

Bond stretching constants and bond-bond interaction constants are in md/A, bond/angle interaction constants are in md/ad and bond-bending constants are in md/Aad.[2]

TABLE III

Frequencies (in cm^{-1}) Observed	Calculated	Observed	Calculated
1270	1282	490	529
675	702	435	409
885	902	225	191
1510	1504	170	161
970	976	340	329
1032	1044	..	..

Out of the eighteen force constants propo to calculate the frequencies, twelve have th same values as those of N, N-dimethylthi acetamide used by the authors in their earl paper. In spite of the fact that one can exp interaction between CH_3 and CH_2 stretchi vibrations, the force constants correspondi to these stretching vibrations were to be alter only from 3·7 in N, N-dimethylthioacetami to 4 in N, N-dimethylthiopropionamide. It significant to note that although C-CH_3 an C-CH_2 stretching vibrational frequencies N, N-dimethylthiopropionamide are con siderably different from each other, the val of the force constants used for these stretchi modes are the same. In spite of the con siderable variation in the stretching and ben ing frequencies of $N{<}^{CH_3}_{CH_3}$ group in N, N-dim thylthioformamide, N, N-dimethylthioacetami and N, N-dimethylthiopropionamide, the stret ing, bending and interaction force constants the $N{<}^{CH_3}_{CH_3}$ group used for the three molecu have the same values. These results broa indicate the validity of transferability of force constants among the related molecu although the vibrational frequencies of corresponding modes are different.

In order to clarify the nature of the obser frequencies and estimate the magnitude of coupling of the various modes of vibrat the potential energy distribution of e normal mode is computed and the correct of the L matrix is verified by the relat $L\tilde{L} = G$. The detailed results obtained regard to the potential energy distribution ν (C-N) vibration among the various symm co-ordinates are given in Table IV. The procedure is followed in regard to the o

TABLE IV

Potential energy distribution of the C-
stretching mode among various symmetr
co-ordinates

R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_1
0	0	0	0	0	0	0	0	0	0
0	16	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	65	− 1	0	0	0	0	0
0	0	0	− 1	8	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	6	0	0	0
0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	5
0	0	0	0	0	0	0	0	0	0
0	16	0	64	7	0	6	1	0	5

modes of vibration and the potential energy distributions of all the in-plane modes thus obtained are given in Table V.

TABLE V

Potential energy distributions of different modes of vibration

Frequency	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}	R_{11}
1270	51	4	0	3	3	1	1	25	7	4	0
675	5	18	11	8	34	2	3	4	3	0	7
885	4	24	51	14	0	10	0	1	3	0	2
1510	0	16	0	65	7	0	6	1	0	5	2
970	6	8	32	0	8	50	0	1	0	0	0
1032	17	6	0	0	20	38	1	0	0	9	8
490	5	8	0	0	0	1	43	10	11	6	16
435	12	0	5	3	30	4	12	29	2	5	1
225	0	0	4	0	0	0	1	14	79	6	8
170	0	0	0	0	2	0	0	13	4	57	22
350	0	0	11	10	0	4	30	0	0	9	35

DISCUSSION OF THE NATURE OF THE ABSORPTION BANDS

The results of the potential energy distribution indicate that the bands at 1270 cm^{-1} and 675 cm^{-1} are essentially due to the asymmetric and symmetric stretching vibration of $N<^{CH_3}_{CH_3}$ group respectively although to the symmetric stretching vibration, the contribution of $\nu(C{=}S)$ is considerable. The frequencies at 885 cm^{-1} and 1032 cm^{-1} are due to $\nu(C{-}CH_2)$ and $\nu(C{-}CH_3)$ stretching vibrations respectively. But to the $C{-}CH_3$ stretching vibration, the contribution of $\nu(C{=}S)$ is considerable. The band at 970 cm^{-1} is assigned to C=S stertching vibration. The results of the potential energy distribution, as given in Table V, indicate that there is a considerable interaction between $\nu(C{=}S)$, $\nu(C{=}CH_2)$ and $\nu(C{=}CH_3)$ stretching vibrations.

The frequencies at 490 cm^{-1} and 435 cm^{-1} are mainly due to the asymmetric and symmetric deformation vibrations of the $N<^{CH_3}_{CH_3}$ group. Similar assignments have been made by the authors in case of dimethylthioformamide and dimethylthioacetamide. The frequencies at 225 cm^{-1}, 170 cm^{-1} and 350 cm^{-1} are essentially due to $\delta(S{=}C{-}N)$, $\gamma(C{-}CH_2)$ and $\gamma(C{-}CH_3)$ vibrations respectively although to the $\gamma(C{-}CH_2)$ vibration, $\gamma(C{-}CH_3)$ makes substantial contribution.

The normal vibrational analysis of ordinary tertiary amides carried out by the earlier wokers[4] indicates that there is a considerable interaction between $\nu(C{-}N)$ and $\nu(C{=}O)$ vibrations. But the results of the potential energy distribution in N, N-dimethylthiopropionamide indicate that such a coupling between these two modes of vibrations is very little. Similar results were obtained by the authors regarding N, N-dimethylthioformamide, and N, N-dimethylthioacetamide.[7] These results are substantiated by similar results obtained in regard to these two modes of vibrations by Suzuki[5,6] in case of thioformamide, N-Methylthioformamide and N-Methylthioacetamide.

---

1. Suzuki, I., *Bull. Chem. Soc. Japan*, 1960, **33**, 1359.
2. —, *Ibid.*, 1962, **35**, 540.
3. Miyazawa, T., Mizushima, S. and Shimanouchi, T., *J. Chem. Phys.*. 1958, **29**, 611.
4. Venkata Chalapathi, V. and Venkata Ramiah, K., *Proc. Ind. Acad. Sci.*, 1968, **68**, 109.
5. Suzuki, I., *Bull. Chem. Soc. Japan*, 1962, **35**, 1286.
6. —, *Ibid.*, 1962, **35**, 540.
7. Indira Chary, C. A. and Venkata Ramiah, K., *Proc. Ind. Acad. Sci.*, 1969, **69**, 18.
8. Shimanouchi, T., *J. Chem. Phys.*, 1956, **25**, 660.
9. Danielewsky, A., *Trans. Moscow Maths. Soc.*, 1937 **44**, 169.

CELLULOLYTIC ACTIVITY OF MARINE FUNGI

A. J. DESAI AND S. M. BETRABET
Cotton Technological Research Laboratory, Bombay-19, India

ABSTRACT

Three marine cellulolytic fungi, two *Aspergillus* sp. and one *Paecilomyces* sp., were isolated from canvas cloth exposed to sea-water in Bomaby. The cultures were screened for cellulase production in eight different media. Enzyme kinetic studies were carried out on the most active isolate, *Aspergillus niger,* using carboxymethyl cellulose and cellulose as substrates. The action of this culture and its filtrate on purified cotton was also studied.

DETERIORATION of cellulosic materials like timber, sail cloth, fish nets and cordages under marine conditions is a major economic problem. Even the marine fouling organisms which bring about heavy destruction of timber submerged in sea-water are aided by microorganisms. The microbes, many of which are cellulolytic, form the primary film on the surface of the timber which eventually helps the settlement of larvae of fouling organisms. The information on Indian marine cellulolytic microorganisms is rather meagre except for the publications of Freitas and Bhat[1,2]; and Venkataraman and Sreenivasan.[3] In view of this, a project is underway at CTRL to isolate, identify and determine cellulolytic activity of marine microorganisms in the sea-water of Bombay. This basic information, it is hoped, will lead to devise preventive methods to save cellulosic material exposed to marine environment. The present paper describes the cellulolytic activity of three fungi and the enzyme kinetics of *Aspergillus niger*, the most active isolate.

Canvas cloth (18 oz/sq yd) was cut into panels of 11″ × 6″ and exposed in the breakwater of Arabian Sea in Bombay in the manner described by Betrabet[4] and the cellulolytic fungi were isolated using Omeliansky's enrichment medium.[5] The cultures were further screened by observing their growth on filter-paper strips. Only three active cultures of fungi, out of 29 that were isolated, were found worth studying. Schemes of Henrici,[6] and Thom and Raper[7] were referred to for their identification. The cultures were: *Aspergillus niger*, *A. fumigatus* and *Paecilomyces* species.

The cultures were screened for cellulase production by growing them in eight different media (pH 5·5) at 28-30° C for eight days. The composition of the media in 100 ml distilled water was as follows:

1. Basal medium with peptone (BMP) containing $MgSO_4.7H_2O$, 0·05 g; KH_2PO_4, 0·1 g; peptone, 0·5 g; and purified cotton, 1 g (BMPP).
2. BMP and Whatman filter-paper, 1 g (BMPF).
3. BMP and cellulose powder, 1 g (BMPC).
4. BMP and saw dust-wheat bran (10 : 1), 1 g (BMPSW).
5. Chaetomium medium[8] with cellulose powder, 1 g (CHC).
6. Chaetomium medium[8] with peptone, 0·25 g; and cellulose powder 1 g (CHPC).
7. Enrichment medium[4] with saw dust-wheat bran (10 : 1), 1 g (ESW).
8. *Trichoderma viride* medium[9] with cellulose powder, 1 g (TVMC).

The enzyme assay system consisted of 5 ml of culture filtrate, 200 mg cellulose powder and 10 ml of 0·2 M acetate buffer, pH 5·6. This system was incubated at 40° C for 2 hr. The reaction was stopped by the addition of 2 ml of Somogyi's copper reagent and the reducing sugar (R.S.) produced was estimated colorimetrically at 520 μ by the method of Somogyi[10] and Nelson.[11] The results of enzyme activities are summarised in Table I.

TABLE I

Cellulolytic activity of cultures in different media

Isolate	R.S. (μg/ml) produced in medium							
	BMPP	BMPF	BMPC	BMPSW	CHC	CHPC	ESW	TVMC
Aspergillus niger ..	10	15	145	65	55	90	70	82
A. fumigatus ..	8	10	45	30	8	45	30	40
Paecilomyces sp. ..	5	4	15	8	10	30	15	23

It is evident from Table I that *A. niger* produced maximum cellulase activity in the medium BMPC. The enzyme kinetic studies described later were conducted using this medium.

The three isolates being of marine origin, a comparative study was made to evaluate the effect of sea-water as compared to the distilled water on the cellulase production. The three media, BMPC, CHPC and TVMC, showing good enzyme production were selected for this comparison. Results are presented in Table II.

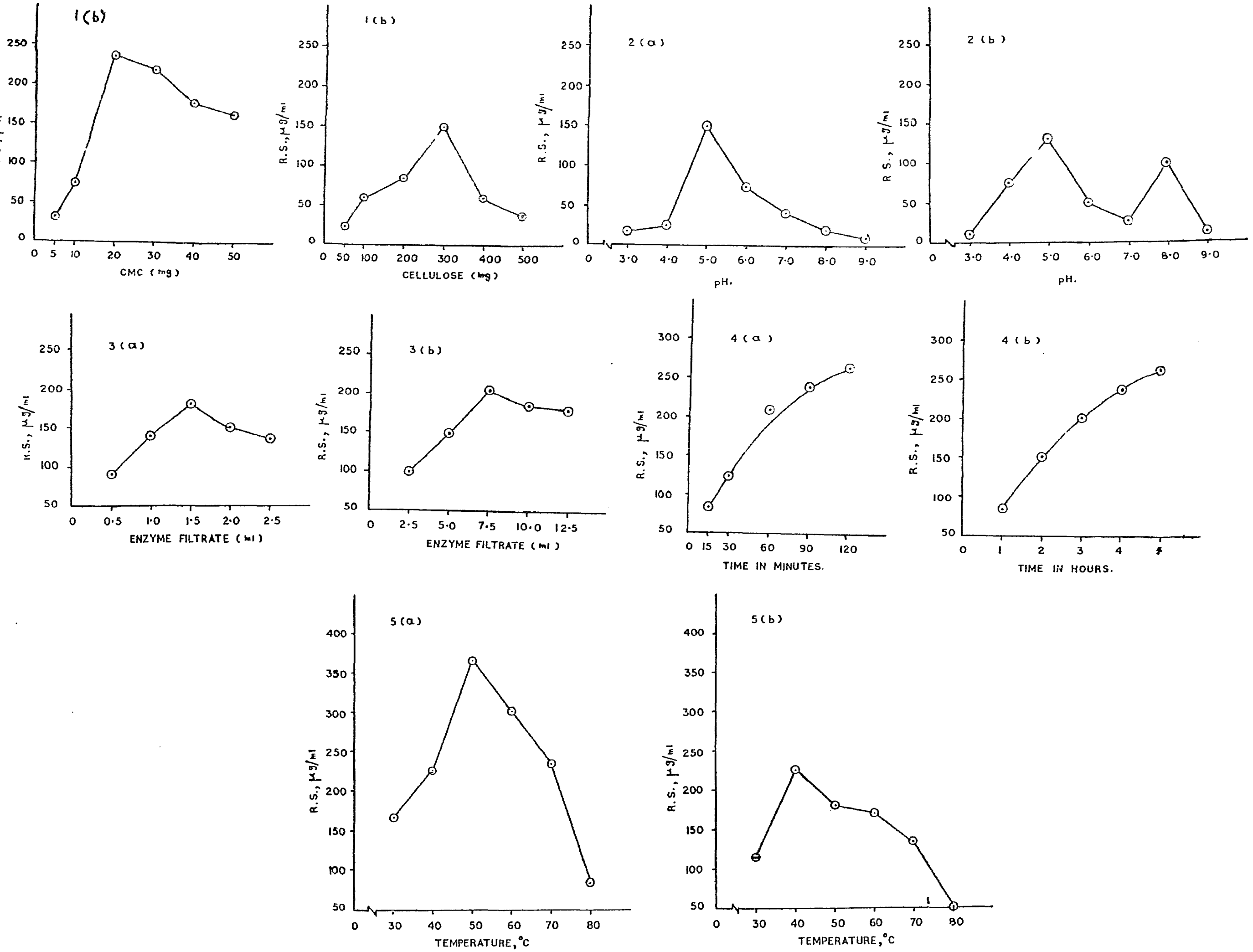
TABLE II

Effect of distilled water (DW) and sea-water (SW) on the cellulase production

Isolate	R.S. (μg/ml) produced in medium					
	BMPC		CHPC		TVMC	
	(DW)	(SW)	(DW)	(SW)	(DW)	(SW)
Aspergillus niger ..	140	45	95	80	79	40
A. fumigatus ..	49	40	42	38	37	36
Paecilomyces sp. ..	17	16	32	28	21	15

Table II shows that distilled water is more favourable to cellulolytic enzyme production than the sea-water medium, especially in the case of *A. niger*. Most likely, these cultures are of terrestrial origin which have adapted to marine conditions.

For the enzyme kinetic studies, *A. niger* showing maximum cellulase production in BMPC medium was selected. Cellulose and carboxymethyl cellulose (CMC) were used as substrates and the various factors with respect to enzyme production studied were: (*i*) effect of substrate concentration, (*ii*) effect



FIGS. 1–5. Carboxymethyl cellulose (*a*), and Cellulose (*b*) activities of marine isolate *Aspergillus niger* with respect to Fig. 1. Effect of substrate concentration; Fig. 2. Effect of pH; Fig. 3. Effect of enzyme concentration; Fig. 4. Effect of incubation time and Fig. 5. Effect of incubation temperature.

of pH, (*iii*) effect of enzyme concentration, (*iv*) effect of incubation time, and (*v*) effect of incubation temperature.

Carboxymethyl cellulase (CMCase) activity was estimated by the method described in an earlier publication.[8] The cellulase activity was determined using cellulose powder as a substrate following the method described earlier. The results are summarized in Figs. 1-5. The optimum substrate concentration is 20 mg for CMCase and 300 mg for cellulase activity. There is a sharp rise at pH 5·6 for CMCase activity while cellulase curve is bimodal having peaks at pH 5·0 and 8·0. Optimum enzyme concentration is 1·5 and 7·5 ml for CMCase and cellulase activity respectively. Incubation time curve is linear in both the cases. Optimum temperature for CMCase is 40° C and for cellulase, 50° C.

Substrate loss and damage to cotton fibres were determined by heavily inoculating BMPP medium with *A. niger* spores. After incubating for 15 days at 28-30° C, the loss in substrate weight was determined by the method of Ghose and King.[12] The fibre damage was also determined by the extrusion test and estimation of copper number.[13] Simultaneously, the effect of cellulolytic enzymes on cotton fibre was determined by soaking 1 g of purified cotton in 200 ml culture filtrate of *A. niger* grown in BMPC. About 0·005% merthiolate was added as a preservative and the system was incubated at 37° C for eight days. Loss in substrate weight, reducing sugar, damage by extrusion test and copper number, were determined on the enzyme-exposed sample. The results are given in Table III.

TABLE III

Characteristics of cotton fibre exposed to A. niger *and its culture filtrate*

Isolate	Substrate loss (%)	Quality count	Cu No.	R.S. (mg/g)
Control ..	..	85	0·02	..
A. niger (direct growth)	11·8	44	0·22	22·5
A. niger (filtrate)	3·2	60	0·14	10·0

A. niger in direct contact with the cotton fibre substrate brings about a loss of about 12%. The cultures filtrate is, however, not very effective. Microbiologists working on the degradation of cotton textiles have normally considered *A. niger* to have only nuisance value such as giving bad appearance and producing odour and stains on cotton fabrics. White *et al.*[14] from their exhaustive study on 52 isolates of *A. niger* had concluded that none of the truly black Aspergilli were found capable of cellulolytic activity. In our own comprehensive survey of cellulolytic microorganisms in the Bombay region of India, we encountered many *A. niger* isolates but they were all very poor decomposers of cellulose as compared to the cultures like *A. ochraceus* and *A. terreus*.[4,13] In view of this, the cellulolytic activity of the marine isolate *A. niger* reported here is of significance.

For the co-operation in exposing fabric panels in the break water, thanks are due to Dr. A. A. Karande of Naval Chemical and Metallurgical Laboratory, Bombay. Thanks are also due to Dr. V. Sundaram, Director, CTRL, for his encouragement.

---

1. Freitas, Y. M. and Bhat, J. V., *J. Univ. Bombay*, 1954, **13**. 53.
2. — and —, *Curr. Sci.*, 1958, **27**, 171.
3. Venkatraman, R. and Sreenivasan, A., *Proc. Natl. Inst. Sci. India*, 1956, **22 B**, 357.
4. Betrabet, S. M., Investigation of the microbial decomposition of cellulose with special reference to the effect of Indian becterial organisms on cotton and cotton fabrics to provide pasic information for the improvement of cotton products, *Final Report—P.L. 480 Project*, C.T.R.L., Bombay, 1968.
5. Peltier, G. L., Georgi, C. E. and Lindgren, L. F., *Laboratory Manual for General Bacteriology*, John Wiley & Sons, Inc., New York, 1952, p. 287.
6. Skinner, C. E., Emmons, C. W. and Tsuchiya, H. M., *Henrici's Molds, Yeasts and Actinomycetes*, John Wiley & Sons, Inc., New York, 1952, p. 94.
7. Thom, C. and Raper, K. B., *A Manual of Aspergilli*, Bailliere Tindall & Cox, London, 1945, p. 86.
8. Betrabet, S. M. and Patel, U. I., *Labdev, J. Sci. & Tech.*, 1969, **7 B**, 221.
9. Mandels, M., Parrish, F. W. and Reese, E. T., *J. Bact.*, 1962, **83**, 400.
10. Somogyi, M., *J. Biol. Chem.*, 1945, **160**, 61.
11. Nelson, N., *Ibid.*, 1944, **153**, 375.
12. Ghose, S. N. and King, K. W., *Text. Res. J.*, 1963, **33**, 392.
13. Betrabet, S. M., Dasani, U. P. and Bhatt, I. G., *Ibid.*, 1968, **38**, 1189.
14. White, W. L., Siu, R. G. H. and Reese, E. T., *Torrey Botan. Club Bul.*, 1948, **75**, 604.

TRANSPORT OF INDOLEACETIC ACID IN BEAN CUTTINGS IN RELATION TO ROOT FORMATION

R. N. BASU*
University of Nottingham School of Agriculture, England

ABSTRACT

Transport experiments with carboxyl-^{14}C-labelled indoleacetic acid have shown that chemicals which interacted negatively with IAA in rooting of *Phaseolus vulgaris* L. cuttings significantly promoted upward movement and accumulation of radio-carbon of IAA-^{14}C applied to the base of the cuttings. The results suggest that increased acropetal movement of basally applied IAA adversely affects adventitious root formation in cuttings.

RECENT evidences indicate that the synergistic effects of phenalic and many other aromatic compounds in rooting cannot be explained on the basis of inhibition of the indoleacetic acid oxidizing system and consequent 'IAA-sparing action' of the synergistic chemicals.[1-4] It has been shown that a number of monophenolic chemicals which did not inhibit the activity of the IAA-oxidizing system promoted auxin-induced rooting, on the other hand, many of the polyphenolic compounds which inhibited the enzyme system did not synergise auxin-induced root formation. The information, so far available, does not give any definite idea of the mechanism of synergism or antagonism in rooting and further research on the physiological and biochemical basis of the positive or negative interactions between auxins and non-auxinic chemicals should be undertaken. The present study was taken up to see how far the synergistic or antagonistic effects of different chemicals are related to transport and distribution of exogenously applied IAA in the cuttings, employing carboxyl-^{14}C-labelled IAA and 15 non-auxinic chemicals listed in Tables I and II.

Seedlings of French bean (*Phaseolus vulgaris* L.) cv. 'Tender green' were grown in vermiculite under controlled light (16 hours light of 1,800 F.C. at plant level and 8 hours dark period in a 24-hour cycle) and temperature (light temperature 21 ± 1° C and dark temperature 18 ± 1° C) conditions in a growth room. When the seedlings were 12 days old, 12-15 cm tall with two primary leaves and the trifoliate bud, 10 cm long cuttings with about 4-6 cm hypocotyl portions and leaf area kept uniform at 10 sq cm per cutting, were made from them. The cuttings were allowed to form adventitious roots in glass vials (Fig. 1), eight cuttings were placed in each vial which contained 6 ml rooting solution of auxin and non-auxinic chemicals at concentrations mentioned in Table I. A separate set of glass vials was employed for the transport experiment in which carboxyl-^{14}C-labelled IAA was employed in place of non-radioactive IAA. The ^{14}C-labelled IAA, 3-indolyl (acetic acid-1-^{14}C), specific activity 33·0 mCi/mM was obtained from the Radio Chemical Centre, Amersham. The specific activity of the labelled auxin was lowered to 3·3 mCi/mM by diluting the radioactive stock with non-radioactive IAA. The cuttings treated with labelled IAA were kept in a radiochemical fumehood to avoid contamination and the cuttings of the rooting experiment on a nearby working table for 24 hours but subsequently transferred to the growth room at the light and temperature conditions mentioned above and kept there till root initiation was complete, watering with distilled water whenever necessary. Data on root formation were taken 10 days after starting the experiment.

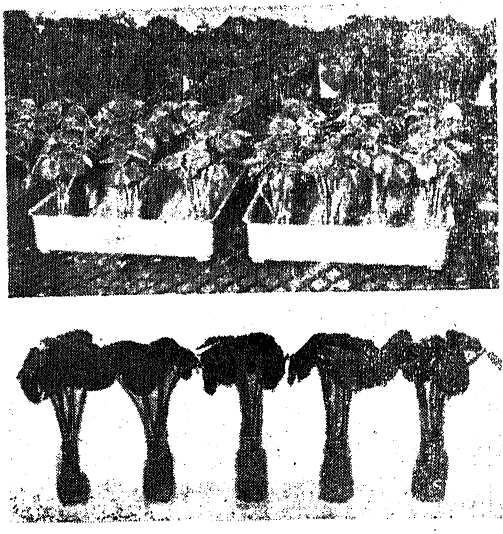


FIG. 1. Photographs showing (above) bean seedlings growing in vermiculite and cuttings in glass vials in the growth room and, (below) rooted cuttings in glass vials ready for taking data on root formation.

---

* Present address: University College of Agriculture, Calcutta University, 35, Ballygunge Circular Road, Calcutta-19.

TABLE I

Interaction of IAA with the different non-auxinic chemicals on rooting of Phaseolus vulgaris *cuttings*

	Mean No. of roots per cutting Control (no auxin)	IAA	Increase (+) or decrease (−) in number of roots per cutting due to synergism or antagonism
Control ..	12·2	14·2	..
Phenol ..	8·2	15·6	+ 5·4
2, 4-Dichlorophenol ..	9·1	13·1	+ 2·0
Guaiacol ..	10·4	15·3	+ 2·9
Hydroquinone ..	8·6	13·8	+ 3·2
Pyrogallol ..	41·3	24·6	−18·7†
p-Hydroxybenzoic acid	11·4	14·6	+ 1·2
Salicylic acid ..	9·1	16·3	+ 5·2
p-Coumaric acid ..	11·8	14·9	+ 1·1
o-Coumaric acid ..	13·1	21·5	+ 6·4
Cinnamic acid ..	14·1	24·1	+ 8·0*
Ferulic acid ..	10·2	18·1	+ 5·9
Caffeic acid ..	13·9	18·4	+ 2·5
Coumarin ..	30·0	24·3	− 7·7*
Indole ..	16·8	31·8	+13·0†
α-Naphthol ..	15·1	24·6	+ 7·5*
L.S.D. at 0·05 P ..	6·1	6·8	..
,, 0·01 P ..	8·4	9·4	..

* Significant at 0·05 P, † Significant at 0·01 P.

Concentration of IAA 5×10^{-5} M, non-auxinic chemicals at 10^{-3} M except 2, 4-DCP at 3×10^{-4} M and salicylic and cinnamic acids at 5×10^{-4} M.

TABLE II

Distribution of radioactivity (CPM) in different sectors of Phaseolus vulgaris *cuttings 24 hours after treatment with IAA-^{14}C*

	Sectors					Total per cutting
	I	II	III	IV	V	
Control ..	3542	600	225	90	63	4520
Phenol ..	2936	463	191	117	62	3769
2, 4-Dichlorophenol	3598	351	179	88	56	4272
Guaiacol ..	4747	497	139	54	47	5484
Hydroquinone ..	4472	631	256	98	63	5520
Pyrogallol ..	3724	955	548	443	115	5785
p-Hydroxybenzoic acid	3287	451	179	104	75	4096
Salicylic acid ..	3475	600	225	90	89	4479
p-Coumaric acid ..	3629	376	160	78	72	4315
o-Coumaric acid ..	3317	501	117	62	75	4072
Cinnamic acid ..	3081	499	170	62	65	3877
Ferulic acid ..	5007	545	143	66	72	5833
Caffeic acid ..	4440	295	130	50	48	4963
Coumarin ..	2959	617	401	206	87	4270
Indole ..	3107	534	222	80	44	3987
α-Naphthol ..	4675	520	120	71	56	5442
L.S.D. at 0·05 P ..	153	40	27	12	14	149
0·01 P ..	206	54	37	16	19	200

Concentration of IAA-^{14}C and non-auxinic chemicals same as in Table I.

Values for synergism or antagonism were obtained by subtracting individual *effects* of IAA and any non-auxinic chemical from the *effect* due to IAA-*cum*-non-auxinic chemical, using the formula $(d-a)-[(b-a)+(c-a)]$, which resolves to $(d+a)-(b+c)$; a, b, c and d being the number of roots per cutting under control, IAA, any non-auxinic chemical and IAA-*cum*-non-auxinic chemical, respectively. Positive values (+) indicate synergism, negative values (−) denote antagonism.

Samples for the assay of radioactivity in cuttings were taken 24 hours after treatment with IAA-^{14}C, by which time the whole of the rooting solution was taken up by the cuttings and the vials had to be supplied with distilled water, and 48 hours after starting the experiment. On each sampling occasion, four cuttings were sampled. The cuttings were divided into five sectors equal in length (each sector 2 cm long); the topmost sector (sector V) included the two leaves (Fig. 2). For the estimation of radiocarbon in tissues, the sectors were separately extracted with ethanol and radioactivity in the ethanolic extracts was assayed on a low background Nuclear-Chicago gas-flow G.M. counting system.

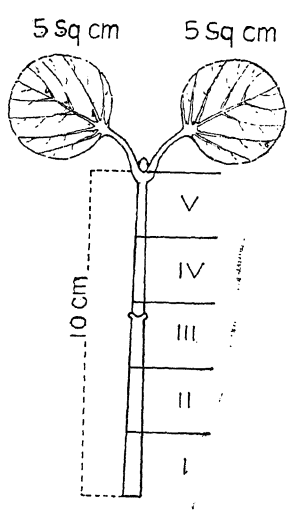


FIG. 2. Diagram showing sectioning of cutting into five equal sectors for the extraction and assay of radioactivity; the fifth (topmost) sector included the leaves.

Pyrogallol and coumarin greatly promoted rooting of bean cuttings when applied alone but interacted negatively with IAA (Table I). The promotion due to indole and α-naphthol did not reach the level of statistical significance in absence of IAA but in combination with the auxin, indole and α-naphthol significantly synergised root formation. Synergism between cinnamic acid and IAA was also significant ($P = 0{\cdot}05$). The synergistic effects of ferulic acid, o-coumaric acid, salicylic acid and phenol were not statistically significant. In all other cases, the effects were either inconspicuous or simply additive.

The trend of distribution and accumulation of radiocarbon in the cuttings under the different treatments was similar in the two sampling occasions. The results obtained with samples taken 24 hours after treatment with IAA-^{14}C are presented in Table II. Total radioactivity per cutting was found to be significantly influenced by the different non-auxinic chemicals. α-Naphthol and the polyphenolic chemicals, guaiacol, pyrogallol, ferulic acid, caffeic acid, and hydroquinone maintained greater radioactivity in cuttings compared to indole, coumarin and the monophenolic compounds such as p-hydroxybenzoic acid, salicylic acid, p-coumaric acid, o-coumaric acid and others. Such differences were due to the differential effects of the chemicals on the activity of the indoleacetic acid oxidizing system.[5] The results confirm the earlier findings[1-4] that synergism in rooting is not dependent on the activity of the IAA-oxidizing system and there is no direct relationship between total radioactivty per cutting and rootability.

As regards the distribution of radioactivity in the different sectors of cuttings, it was noted that pyrogallol and coumarin, the two chemicals which showed negative interaction with IAA in rooting exhibited greater upward movement and accumulation of ^{14}C in the upper sectors of the cuttings. None of the synergistic chemicals showed such promotion of upward movement of radiocarbon. The synergistic chemicals, however, showed minor differences amongst themselves but such differences were not consistently correlated with the degree of synergistic effects of the respective chemicals. The non-promotion of accumulation of radiocarbon in the tops of cuttings in presence of synergistic chemicals and the association of antagonism with increased upward movement and accumulation of radiocarbon of IAA-^{14}C suggest that for optimum rooting the exogenously applied auxin should be confined to the basal root-forming region of cuttings and distributon of basally applied IAA over a longer region of the cutting would adversely affect adventitious root formation.

The possibility of formation of different IAA-non-auxinic chemical complexes[6,7] and subsequent differential movement of such complexes to the upper parts of the cuttings is doubtful in view of the almost identical pattern of incorporation of radiocarbon of IAA-^{14}C in presence of different non-auxinic chemicals (Fig. 3). It was noted that even after 24 hours, most of the radiocarbon of IAA-^{14}C was incorporated into different compounds and after such incorporation of the ^{14}C into other compounds, there was little change in total radioactivity. The differences in the relative intensities of spots on the radioautograms were due to differential effect of the non-auxinic chemicals on IAA decarboxylation prior to incorporation into other compounds. Whether in presence of antagonistic chemicals, certain of the products into which ^{14}C of the labelled IAA is incorporated show greater upward movement and accumulation in upper portions of the cuttings requires further investigation.

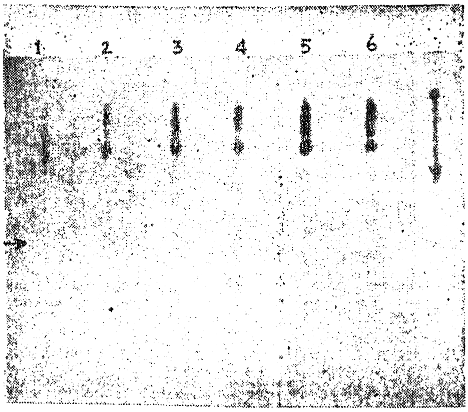


FIG. 3. Radioautograms of chromatograms of ethanolic extracts of IAA-^{14}C-treated cuttings showing incorporation of radiocarbon into different compounds from left to right (1) IAA-^{14}C + Indole, 24 hours after treatment, (2) same after 48 hours, (3) IAA-^{14}C + α-Napthol after 24 hours, (4) same after 48 hours, (5) IAA-^{14}C + Ferulic acid after 24 hours, (6) same after 48 hours; arrow on left shows the zone of resolution of synthetic IAA-^{14}C, arrow on right indicates the direction of solvent run.

The author is thankful to Professor M. B. Wilkins for laboratory facilities and his interest in this study, the British Council for a Travel Grant under Commonwealth University Interchange Scheme, and the Calcutta University for the award of Sir R. B. Ghosh Travelling Fellowship and study leave.

---

1. Basu, R. N., *Curr. Sci.*, 1969, **38**, 533.
2. Gorter, C. J., *Physiol. Plant.*, 1969, **22**, 497.
3. Basu, R. N., Bose, T. K., Roy, B. N. and Mukhopadhyay, A., *Ibid.*, 1969, **22**, 649.
4. —, *Indian J. Plant Physiol.*, 1970, **13** (in press).
5. Mahadevan, S., In *Modern Methods of Plant Analysis* (Ed K. Paech and M. V. Tracey), Springer-Verlag, Berlin, pp. 238.
6. Leopold, A. C. and Plummer, T. H., *Plant Physiol.*, 1961, **36**, 589.
7. Fadl, M. S. and Hartmann, H. T., *Ibid.*, 1967, **42**, 541.

LETTERS TO THE EDITOR

THE DISTRIBUTION OF THE MEANS OF SAMPLES FROM TRUNCATED EXPONENTIAL POPULATIONS

MANY of the investigations undertaken in the course of scientific studies are on samples from truncated populations or they finally reduce to censored samples. The analysis of such data is done by estimating the parameters and their variances and co-variances by the maximum likelihood procedure. For purposes of testing, it is assumed that the distribution of the estimates are asymptotically multivariate-normal. Very little work on the distribution of the means and other statistics of samples from truncated populations or of censored samples exists at present. If this distribution is available, the statistical tests for comparing the results of two samples can be made more precise.

The purpose of this communication is to give the distribution of means of samples from truncated exponential populations. The density function of a truncated exponential is given by

$$f(x) = \frac{\alpha e^{-\alpha x}}{1 - e^{-\alpha \xi}}, \quad 0 \leqslant x \leqslant \xi.$$

$\overset{n}{\underset{r=1}{\Pi}} f(x_r)\,dx_r$ is the probability for the occurrence of a random sample with values $x_1, x_2, \ldots\ldots x_n$. The distribution of the mean of this sample can be obtained by using the method of characteristic functions as has been done by Irwin[1] for samples from a rectangular distribution. This can also be derived by using the results of Dirichlet's integral as indicated by Iyer.[2] The distribution of the mean $\bar{x}$ reduces to

$$\frac{(\alpha n)^n}{(n-1)!\,(1 - e^{-\alpha \xi})^n} e^{-\alpha n \bar{x}}$$

$$\times \sum_{r=0}^{r=k} (-)^r \binom{n}{r} \left(\bar{x} - \frac{r\xi}{n}\right)^{n-1} d\bar{x}$$

for the region

$$\frac{k\xi}{n} \leqslant \bar{x} \leqslant \frac{(k+1)\,\xi}{n}.$$

The distribution differs from region to region and consists of n separate arcs for the regions

$$0 \leqslant \bar{x} \leqslant \frac{\xi}{n};\ \frac{\xi}{n} \leqslant x \leqslant \frac{2\xi}{n};\ \ldots;$$

$$\frac{k\xi}{n} \leqslant x \leqslant \frac{(k+1)\,\xi}{n};\ \ldots\ \frac{(n-1)\,\xi}{n} \leqslant \bar{x} \leqslant \xi.$$

It will be noted that this method can be used for obtaining the distribution of the means and variances of samples from a number of other truncated distributions. These aspects will be discussed in a paper to be published shortly.

Dept. of Mathematics, P. V. KRISHNA IYER.
University of Queensland,
St. Lucia, Brisbane,
June 1, 1971.

---

1. Irwin, J. O., *Biometrika*, 1927, **19**, 225.
2. Iyer, P. V. K., *Ind. Acad. Sci.*, 1945, **22**, 75.

SUBSTITUTED BENZOTHIAZOLYL GUANIDINES

MANY biguanides[1] and guanidines are found to have antimalarial,[2] antitubercular[3,4] and anti-bacterial[5] activities which created interest in searching for useful members in this series. Recently, Bhargava *et al.*[6] have shown that hydrochlorides of several benzothiazolyl guanidines are more active against gram-positive bacteria than against gram-negative ones. Some N-*m* (or *p*)-tolyl-N′-2-(substituted) benzothiazolyl-N′-alkyl-guanidines have been found active against *M. tuberculosis* ($H_{37}R_v$).[7,8]

Considering the above activities, the authors have synthesised some new N-benzyl-N′-2-(substituted) benzothiazolyl N″-butyl guanidines.

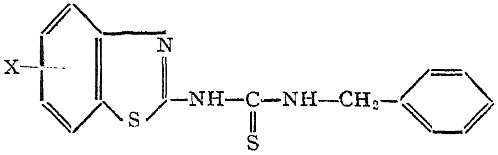
EXPERIMENTAL

N - Benzyl - N′ - 2 -(substituted) benzothiazolyl thiocarbamides.—These were prepared by condensing 2-amino-(substituted) benzothiazoles[9,10] with benzylisothiocyanate.[11] The yields, melting points and analytical data are reported in Table I.

N - Benzyl - N′ - 2 - (4-methyl) benzothiazolyl-N″-butyl guanidine.—A mixture of N-benzyl-N′-2-(4-methyl) benzothiazolyl thiocarbamide (3·3 g), yellow lead oxide (5 g) and butylamine (3·2 ml) in ethanol (30 ml) was heated in glass autoclave on a water-bath for about 4 hr. After cooling, the tube was opened carefully and the reaction mixture was filtered while hot. The black precipitate was extracted further with 20 ml of hot ethanol. The combined filtrates upon concentration gave the desired guanidine in crystalline form. It was recrystallised from ethanol, m.p. 101° C, yield 72%.

TABLE I

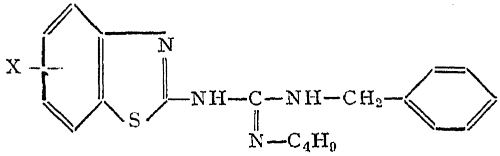
N-Benzyl-N′-2-(substituted) benzothiazolyl thiocarbamides



S. No.	Substituent X	Yield %	M.P. °C.	Molecular formula	Nitrogen, % Found	Nitrogen, % Calcd.	Sulphur, % Found	Sulphur, % Calcd.
1	H	84	193	$C_{15}H_{13}N_3S_2$	14·01	14·05	21·44	21·40
2	4-Methyl	72	168	$C_{16}H_{15}N_3S_2$	13·31	13·42	20·54	20·45
3	5-Methyl	76	195	$C_{16}H_{15}N_3S_2$	13·40	13·42	20·58	20·45
4	6-Methyl	70	208	$C_{16}H_{15}N_3S_2$	13·28	13·42	20·61	20·45
5	4-Chloro	70	218	$C_{15}H_{12}N_3S_2Cl$	12·65	12·60	19·38	19·20
6	5-Chloro	65	226	$C_{15}H_{12}N_3S_2Cl$	12·42	12·60	19·42	19·20
7	6-Chloro	75	204	$C_{15}H_{12}N_3S_2Cl$	12·38	12·60	19·12	12·20
8	6-Bromo	80	210	$C_{16}H_{12}N_3S_2Br$	10·97	11·11	16·98	16·93
9	4-Methoxy	73	180	$C_{16}H_{15}N_3OS_2$	12·56	12·76	19·62	19·46
10	6-Methoxy	80	154	$C_{16}H_{15}N_3OS_2$	12·63	12·76	19·67	19·45
11	4 Ethoxy	72	172	$C_{17}H_{17}N_3OS_2$	12·18	12·25	18·75	18·66
12	6-Ethoxy	80	165	$C_{17}H_{17}N_3OS_2$	12·21	12·25	18·69	18·66

TABLE II

N-Benzyl-N′-2-(substituted) benzothiazolyl-N″ butyl guanidines



S. No.	Substituent X	Yield %	M.P. °C.	Molecular formula	Nitrogen, % Found	Nitrogen, % Calcd.	Sulphur, % Found	Sulphur, % Calcd.
1	H	65	99	$C_{19}H_{22}N_4S$	16·62	16·57	9·60	9·46
2	5-Methyl	62	88	$C_{20}H_{24}N_4S$	15·82	15·92	9·18	9·09
3	6-Methyl	58	198	$C_{20}H_{24}N_4S$	15·80	15·92	8·98	9·09
4	4-Chloro	55	170	$C_{19}H_{21}N_4SCl$	15·00	15·03	8·70	8·59
5	6-Chloro	70	156	$C_{19}H_{21}N_4SCl$	15·12	15·03	8·50	8·59
6	6-Bromo	75	195	$C_{19}H_{21}N_4SBr$	13·32	13·43	7·80	7·67
7	4-Methoxy	52	120*	$C_{20}H_{25}N_4OSCl$	13·71	13·85	9·01	7·91
8	4-Ethoxy	60	155	$C_{21}H_{26}N_4OS$	14·68	14·66	8·56	8·37

* Melting point of the hydrochloride.

(Found N, 15·79 ; S, 9·20 ; $C_{20}H_{24}N_4S$ requires N, 15·92 ; S, 9·09%.)

Similarly, various N-benzyl-N′-2-(substituted)benzothiazolyl-N″-butyl guanidines were prepared. Their melting points, yields and analytical data are reported in Table II.

Pharmacological screening results.—Some of these compounds were tested for their pharmacological and microbiological activities at Bristol Laboratories, Syracuse, New York, U.S.A. The compounds N-benzyl-N′-2-(4-methyl) benzothiazolyl–N″–butyl guanidine showed CNS depressant analgesic activities at minimal effective doses of 300 and 73 respectively. Other compounds were inactive.

Thanks are due to the Council of Scientific and Industrial Research, New Delhi, for the award of a Junior Research Fellowship to one of us (S. N. S.).

Dept. of Chemistry,
Faculty of Science,
Banaras Hindu University,
Varanasi-5, *April* 6, 1971.

P. N. BHARGAVA.
S. N. SINGH.

---

1. Rose, F. L. and Swain, G., *J. Chem. Soc.*, 1956, p. 4422.
2. Bhargava, P. N. and Ram, P., *Indian J. Chem.*, 1966, **4**, 95.
3. Jaysimha, B. N., Bhattacharya, S. C. and Guha, P. C., *Curr. Sci.* (India), 1951, **20**, 158.
4. Sirsi, M., Jaysimha, B. N. and Iyengar, J. R., *Ibid.*, 1951, **20**, 237.
5. Curd, F. H. S. and Rose, F. L., *J. Chem. Soc.*, 1946, p. 729.
6. Bhargava, P. N. and Devi, K. S., *J. Indian Chem. Soc.*, 1963, **40**, 868.
7. — and Lakhan, R., *Agr. Biol. Chem.*, (Tokyo), 1968, **32**, 1392.
8. — and Chaursia, M. P., *Curr. Sci* (India), 1968, **37**, 347.
9. Hugershoff, A., *Ber.*, 1903, **36**, 1321.
10. Bhargava, P. N. and Baliga, B. T., *J. Indian Chem. Soc.*, 1958, **35**, 807.
11. — and Ram, P., *Indian J. Appl. Chem.*, 1961, **24**, 181.

STUDIES ON YTTRIUM, THORIUM AND URANIUM SALICYLALDEHYDE COMPLEXES

SALICYLALDEHYDE complexes of La^{3+}, Ce^{3+}, Pr^{3+} Nd^{3+}, Sm^{3+} and Eu^{3+} were reported.[1] This communication details the preparation and a study of spectral properties of yttrium, thorium and uranium salicylaldehyde complexes.

It was reported[1] that the lanthanide salicylaldehyde complexes may be prepared by the addition of sodium salt of salicylaldehyde to the rare earth cation or by the direct addition of salicylaldehyde to the rare earth cation in the presence of piperidine which acts as a hydrogen ion acceptor. The addition of piperidine, it was stated, is not recommended since it is often retained in the product and excessively high temperatures may be required for complete desolvation.[2]

Yttrium, thorium and uranium salicylaldehyde complexes were prepared by the method described by Alire[3] with a slight modification. The procedure employed involves the addition of a calculated amount of salicylaldehyde to the metal cation in ethanol medium and a subsequent addition of alcoholic ammonia to act as a hydrogen ion acceptor. The pH of the solution was adjusted to 5·0 in case of yttrium complex and 3·5 in case of thorium and uranium complexes when the solids separated. All the complexes were washed with ether to remove the excess ligand. They were dried over fused calcium chloride for 48 hours. The metal to ligand ratio was found to be 1 : 3 in the case of yttrium and thorium and 1 : 1 in the case of uranium complexes, both by elemental analysis and also by igniting a known weight of the complex in a platinum crucible and weighing the residual oxide.

[Found C = 55·20% ; H = 3·26% ; Y = 19·23%. $Y(C_7H_5O_2)_3$ requires C = 55·70% ; H = 3·13% ; Y = 19·66%.]

[Found Th = 35·20% ; $Th(C_7H_5O_2)3.NO_3.H_2O$ requires Th = 34·38%.]

[Found U = 49·50% ; $UO_2(C_7H_5O_2).NO_3.H_2O$ requires U = 48·09%.]

The absorption spectra of the ligand and the chelates in the ultraviolet and visible region were recorded using a Unicam SP-500 spectrophotometer and in the infrared region on Perkin Elmer Model 137 infracord (yttrium and uranium) and on Perkin Elmer Model 521 (thorium). The solids were examined as either nujol mulls or KBr discs.

In the ultraviolet region the ligand exhibits two band maxima, one at 325 mμ and the other at 255 mμ in the solvent methanol. In the chelates investigated the two band maxima are located without any shift. Only slight changes in the intensification are noticed. The λ_{max} and log $\epsilon_{max.}$ values of the ligand and the chelates are detailed in Table I.

TABLE I

Compound		$\lambda_{max.}$ (in mμ)	Log $\epsilon_{max.}$
Salicylaldehyde	..	255	3·60
		325	3·72
Yttrium complex	..	255	3·86
		325	3·84
Thorium complex	..	255	3·96
		325	3·91
Uranium complex	..	255	2·94
		325	2·54

The infrared spectra of salicylaldehyde and it's metal chelates was studied by Bellamy and Beecher.[4] They observed a band around 1668 cm⁻¹ in the free salicylaldehyde and assigned it to the chelate type of structure. The carbonyl frequency observed in the salicylaldehyde was changed considerably on complexation with divalent metal ions.[5] However, the carbonyl frequency was observed around 1657 ± 4 cm⁻¹ in all the lanthanide complexes.[1] It was pointed out that this behaviour of lanthanides is different from that of divalent metal salicylaldehyde chelates where the carbonyl frequency varied markedly among themselves.

In the present investigation the carbonyl frequency was located at 1635 and 1640 cm^{-1} in the case of uranium and thorium complexes respectively and around 1649 cm^{-1} in the case of yttrium complex.

Dept. of Chemistry, Y. H. DESHPANDE.
Marathwada University, V. RAMACHANDRA RAO.
Aurangabad, *May* 4, 1971.

---

1. Charles, R. G., *J. Inorg. Nucl. Chem.*, **1964**, **26**, 2298.
2. — and Perrotto, *Ibid.*, **1964**, **26**, **373.**
3. Alire, R. M., *Ph.D. Thesis*, University of New Mexico, 1962.
4. Bellamy, L. J. and Beecher, L., *J. Chem. Soc.*, 1954, p. 4488.
5. — and Branch, R. F., *Ibid.*, 1954, p. 4491.

A PRELIMINARY NOTE ON THE WADHWAN FORMATION OF SAURASHTRA

THE Wadhwan sandstone reported by Fedden from around Wadhwan (22° 42′ : 71° 44′) to consist of a calcareous sandstone with a thin band of limestone at its top, was on the basis of a few fragmentary molluscan fossils considered Lower Cretaceous in age and to resemble the Bagh Beds of the Narbada Valley (Fedden, 1884, p. 84; Arkell, 1956, p. 392; Krishnan, 1968, p. 254).

Our recent work in that area has shown it to be a much better developed sequence (*vide* Table I) of a thick coarse- to medium-grained calcareous sandstone, the Surendranagar Sandstone, succeeded by the argillaceous Navania Limestoone, with the Bhaduka Limestone, a silicified bryozoan limestone comming at the top of the series.

In the field by their sequence and lithological characteristics, these members of the Wadhwan Formation are very closely similar to the three most widely-occurring constituents of the Bagh Beds (*vide* Table I).

Several of the Bagh species are found to occur in these Wadhwan rocks among which may be mentioned *Pycnodonta boucheroni* (Coq.), *Lima granulicostata* Chiplonkar and Badve, *Liostrea rouveli* (Coq.), *Paraesa faba* (Sow.), *Protocardia pauli* (Coq.), *Voluta elongata* (d'Orb.), *Nucleolites rajnathi* (Chiplonkar), *N. chirakhanensis* (Chiplonkar), *Hemiaster subsimilis* Fourtau and *Archaeolithothamnium saurashtraensis* Chiplonkar and Borkar.

Better preserved material would probably enable us to establish the presence in the Wadhwan Formation of some more of Bagh species, e.g., *Spondylus latus* (Sow)., *Proplacenticeras stantoni* Hyatt var. *bolli* (Hyatt),

TABLE I

Wadhwan Area				Narbada Valley
Fedden (1884)		Present Authors		
Deccan Trap		Deccan Trap		Deccan Trap
Cherty Freshwater Beds		Lamata		Lamata
Wadhwan Sandstone: Calcareous sandstone with a thin band of limestone at top	Lower Cretaceous	Wadhwan Formation: (1) Bhaduka Limestone: Silicified bryozoan limestone with molluscs, echinoids, algae, etc., with oyster bed at top 5 m–25 m (2) Navania Limestone: Argillaceous, with small oysters and some echinoids 1 m–2 m (3) Surendranagar Sandstone: Marine, calcareous, massive, generally fossiliferous with molluscs, echinoids, bryozoans, algae, etc. 5 m–10 m	Cenomanian Turonian	Bagh Beds: (1) Coralline Limestone: Silicified bryozoan limestone with molluscs, echinoids, algae, etc., with Deola Marl in the middle and oyster bed at top 2 m–12 m (2) Nodular Limestone: Sometimes argillaceous; molluscs, echinoids, etc. 7 m–14 m (3) Nimar Sandstone: Extensively false-bedded, oyster bed at top and in the middle; but generally nnfossiliferous; partly fluviatile 15 m–30 m
Umia Beds		Umia and Dhrangadhara Beds		Bijawars and Archaeans

Cidaris namadicus Duncan, *Malwirhynchia transversalis* Chiplonkar and *M. subpentagonalis* Chiplonkar.

British and French species, *e.g., Neithea gibbosa* (Pult.), *Lima cretacea* Woods, *L. meyeri* Woods, *Opis haldonensis* Woods, *Volutilithes orbignyana* Müller, *Turbo alsus* d'Orb., to be found occurring in the Wadhwan rocks add further to their faunal interest.

Such a fossil assemblage indicates for the Wadhwan Formation, a younger age, more like Cenomanian-Turonian, than what was till now assigned to them (*vide supra*), and their affinities, like those if the Bagh Beds (Chiplonkar, 1937-42), with the Mediterranean palaeozoo-geographic province.

The points on which these Wadhwan strata differ somewhat from the Bagh Beds are that the Surendranagar Sandstone is more generally fossiliferous and rarely false bedded in contrast to the Nimar Sandstone; the argillaceous Navania Limestone is much poorly developed as compared to the Nodular Limestone; while the Bhaduka Limestone is much better developed that the Coralline Limestone, its counterpart in the Bagh Beds.

These differences probably indicate that these Wadhwan sediments were deposited more towards the open sea than in the narrow gulf where the Bagh Beds were probably laid down.

Maharashtra Association for the Cult. of Sci., Poona-4, *April* 3, 1971.

G. W. CHIPLONKAR.
V. D. BORKAR.

---

1. Arkell, W. J., *Jurassic Geology of the World*, 1956.
2. Chiplonkar, G. W., *Proc. Ind. Acad. Sci.*, *(B)*, 1937-42, **6** (1); **9** (5); **10** (4); **15** (3).
3. Fedden, F., *Mem. Geol. Surv. Ind.*, 1884, **22** (2).
4. Krishnan, M. S., *Geology of India and Burma*, 5th ed., 1968.

CORALLOIDAL CALCITE FROM A MICA MINE IN NELLORE DISTRICT, ANDHRA PRADESH

THE occurrence of stalctitic calcite of white colour with radiating structure, formed by the evaporation of trickling carbonated mine waters, is not an uncommon feature in the abandoned tunnels and galleries of the underground mica mines of the Nellore granitic pegmatite belt of Andhra Pradesh State.[1] An unusual occurrence of calcite entirely different from the stalctitic variety was observed for the first time about a year ago, while dewatering a water-logged gallery, abandoned for about three years and located at 30-metre level of the Seetharama Mica Mine (57 N/11; Lat. 79° 43′ 43″, Long. 14° 17′ 5″) in Kalichedu Village of Rapur Taluk in Nellore District.

The mineral is light grey in colour and shows coralloidal structure by containing groupings of fine elongated fibres of less than 0·1 mm thickness, interlacing flexuous branchings and coalescing stems having a maximum thickness of about 3 mm (Fig. 1). An unusual feature noticed is that the fibres of calcite show a positive sign of elongation and a negative optic sign, indicating that the optic axis of the mineral is perpendicular to its direction of elongation. As it is known that the direction of elongation in calcite generally coincides with its optic axis, a suggestion is offered that the original material was represented by optically positive vaterite (μ-$CaCO_3$) having its optic axis parallel to the direction of elongation, which later inverted to calcite, pseudomorphous after vaterite, having its optic axis normal to the direction of elongation. On determining the refractive index of the mineral in yellow light by the standard immersion method, it is found that the ω value is 1·650, which is a little less than that of pure calcite (1·658). The low refractive index obtained for the mineral compared to that of calcite has been suggested to be a diagnostic property of calcite formed at the expense of vaterite.[2]

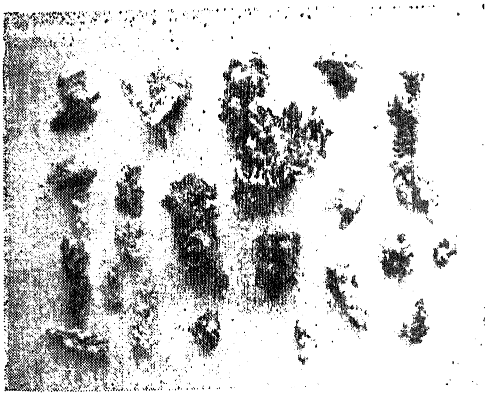


FIG. 1. A photograph of coralloidal calcite shown in the background of a centimetre-graph.

The mineral was ground to a fine powder in an agate mortar, washed free of chloride with distilled water and dried at 105° ± 5° C. The acid-soluble portion of the mineral was analysed by an adaptation of the method of Shapiro and Brannock[3] and the results are presented in Table I. From an estimation of organic carbon by the method of Schollenberger, as modified by Allison,[4] it is observed that the mineral is practically devoid of organic matter.

TABLE I

Chemical analysis of coralloidal calcite

Oxide	Wt. %	Numbers of ions on the basis of 6 oxygens		
MgO ..	0·30	Mg	0·030	2·01
Fe_2O_3 ..	0·13	Fe^{+3}	0·003	
CaO ..	54·00	Ca	1·978	
Na_2O ..	0·41	C	1·994	
K_2O ..	0·25			
CO_2 ..	42·71			
Insol. residue	1·80			
	99·60			

Analyst: C. V. Seshadri

The mineral at the first impression gave the idea that it was grown as a result of biological activity. The possibility of these growths being of vegetable origin is ruled out from the absence of natural or artificial light necessary for the formation of chlorophyll. The absence of organic carbon in the mineral further confirms the view that these growths are only of inorganic origin. From the experimental work of Faivre[5] that vaterite, which rapidly inverts to calcite, precipitates from a solution of $CaCl_2$ and Na_2CO_3 at temperatures between 60° and 35° C, it is suggested that conditions similar to that described by Faivre were created in the mine for the growth of vaterite, which later inverted to calcite of coralloidal structure. With the dewatering of the gallery and commencement of mining activities and extension of artificial ventilation facility to portions of the mica mine nearby the gallery, conditions favourable for the growth of coralloidal calcite have ceased to exist.

Occurrence of coralloidal calcite is not known, although a variety of aragonite showing coralloidal structure, *i.e.*, *flos-ferri*, is known to occur in association with the iron-ore beds of the Styrian mines in Oregon Mountains of New Mexico.[6]

The authors wish to thank Dr. M. G. Chakrapani Naidu, Professor and Head of the Department of Geology, for providing facilities and encouragement. One of the authors (C. V. Seshadri) expresses his gratitude to the C.S.I.R., New Delhi, for financial assistance.

Dept. of Geology, C. V. SESHADRI.
Sri Venkateswara R. JAGADISWARA RAO.
University, Tirupati,
and
Seetharama Mica Mine, K. V. S. RAM.
Kalichedu, Nellore Dist.,
April 24, 1971.

---

1. Jagadiswara Rao, R., Unpublished *Ph.D. Thesis*, Sri Venkateswara University, Tirupati, 1965.
2. Reddy, K. R., Jagadiswara Rao, R. and Chakrapani Naidu, M. G., *J. Geol. Soc. India*, 1971, **12**, 80.
3. Shapiro, L. and Brannock, W. W., *U. S. Geol. Surv. Bull.*, 1962, **1144 A**, 1.
4. Allison, L. E., *Soil Sci.*, 1935, **40**, 311.
5. Faivre, R., *Compt. Rend. Acad. Sci.*, 1946, **222**, 140.
6. Dana, E. S. and Ford, W. E., *A Text Book of Mineralogy*, IV ed., John Wiley & Sons, Inc., New York, 1932.

ON THE OCCURRENCE OF CALCAREOUS ALGA FROM THE KALHEL LIMESTONE, KALHEL, CHAMBA DISTRICT, H.P.

THE present note records the occurrence of a calcareous alga in the Kalhel limestone from the type locality Kalhel (32° 45′ 00″ : 76° 11′ 28″). This note bears some importance as it constitutes the first find of these organisms *in situ* in addition to the crinoid oscicles recorded by McMahon[1] and fossils reported by Gupta and Bedi,[2] and Gupta.[3]

The Kalhel limestone is of bluish-grey colour and rests over the Agglomeratic slates and Panjal traps succession of the Chamba syncline. McMahon[1] assigned this limestone to Upper Silurian, whereas Gupta and Bedi[2] considered it to be of Lower to Middle Carboniferous age. Gupta,[3] and Fuchs and Gupta[4] have correlated this limestone succession with the Zewan Series of Kashmir.

The sample containing fossil alga came from the limestone band rich in crinoid oscicles. Alga is not observed in the hand specimens. Under the microscope, however, the cellular structure of the alga is very distinct. The framework is made up of thread-like structures woven into a net (Fig. 1). The threads are essentially composed of ferruginous material which is now completely altered to limonite,

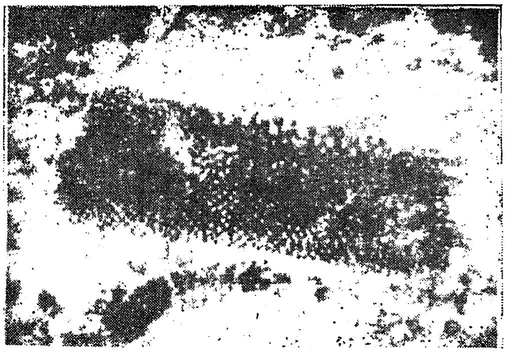


FIG. 1. Fossil alga from the Kalhel limestone, × 80.

The interspaces between the threads are invariably composed of calcite and are rather squarish in shape. On account of the widespread recrystallisation of this limestone, most of the algal parts are either partly or completely obliterated destroying all the essential characters needed for identification at the generic or specific level. It is, thus, very difficult to establish specific or generic affinities of this alga. On the basis of the algal network, however, it is strongly suspected that the algal genus belongs to the family Dasycladacea.

Centre of Advanced Study
in Geology,
Panjab University,
Chandigarh, *March* 29, 1971.

V. J. Gupta.
P. C. Dixit.

---

1. McMahon, C. A., *Rec. Geol. Surv. Ind.*, 1883, **16**, 40.
2. Gupta, V. J. and Bedi, R. S., *Bull. Ind. Geol. Assoc.*, 1970, **3**, 32.
3. Gupta, V. J., *Verhandlungen der Geologischen Bundenstalt in Wien*, 1971 (In press).
4. Fuchs, G. and Gupta, V. J., *Ibid.*, 1971 (In press).

ON THE DISCOVERY OF MAMMALIAN AND REPTILIAN REMAINS FROM THE MIDDLE EOCENE ROCKS OF S.W. KUTCH, INDIA

The note reports for the first time the occurrence of mammalian and reptilian fossil remains from the Middle Eocene (Leutetian) formation of western India. The mammalian and reptilian remains were earlier recorded by the author[1] as ossiferous zone from Kutch. The ossiferous zone forms part of a sequence exposed in the Ratchelo stream section about 2 kilometers north of Harudi (23° 30′ 20″ : 68° 43′ 40″) village, S.W. Kutch. The beds dip at a low angle of 3° to 7° towards south-west. The following is the biostratigraphic sequence:

		Thickness in metres
Middle Eocene	*Nummulites acutus* zone	3·0
	Reptilian Zone	4·5
	Corbula subexarata zone	1·5
	Dicot. leaf zone	1·0
	Unfossiliferous zone	24·0
	……Unconformity……	
Lower Eocene	*Assilina subspinosa* zone	8·0

The unfossiliferous zone lies unconformably over the Lower Eocene rocks and is about 24 m in thickness. It consists of ferruginous shales at the base followed by variegated and green gypseous clays. The ferruginous shales show mud cracks, gas pits and concretions.

The unfossiliferous zone is overlain by a metre thick dicot leaf zone. It predominantly consists of freshwater red shales with fairly large number of well-preserved dicot leaf impressions and few pieces of fossil wood.

Corbula subexarata zone lies over the dicot leaf zone and is about 1·5 m in thickness. This zone consists of light green-coloured clays and is overlain by a fairly consistent thin band of compact chocolate-brown fossiliferous limestone. This limestone forms a platform like topographical feature. A rich fauna consisting of *Corbula subexarata* d'Archiac, *Meretrix (Callista) yawensis* Cotter, *Meretrix* sp., *Ostrea* sp., *Anomia* sp., *Nuculana* sp., *Unicardium* sp., *Gonus* sp., *Nautilus* sp., *Lockhartia* sp., *Cytherelloidea barkhanensis* Tewari and Tandon, *Bairdia* sp., *Paijenborchella* sp., etc., is present. Besides these forms, fossil vertebrae, broken jaws of mammals belonging probably to order Cetacea along with fish teeth remains are also found.

Corbula subexarata zone is overlain by 4·5 m thick reptilian zone, which consists of light-grey clays. At the base of clays, there is about 30-50 cm thick dark-grey gypseous marl. This band is rich in reptilian remains and contains highly gypsified skulls of *Crocodilus kutchensis* n. sp., *Crocodilus* (?) sp. A. A number of gypsified vertebrae, probably belonging to forms mentioned above are found scattered. A single reptilian brain case has also been found.

Nummulites acutus zone lies over reptilian zone and is about 3 m thick. It consists of yellowish-green clays and marls. This zone marks a sudden change in fauna, which may be due to the further deepening of the sea. The genus *Nummulites* in Middle Eocene rocks first appears in this zone.

In the area under investigation, the short-lived regression of sea and unconformity after the Lower Eocene period is well marked by presence of ferruginous shales, which might have been deposited under very shallow water conditions as is evident by mud cracks and ferruginous concretions. High ferruginous content indicates a hot and arid climate and such conditions continued up till the deposition of variegated clays and green gypseous shales, as is supported by the presence of evaporites. Presence of dicot leaf impressions and fossil wood is indicative of prevalent freshwater conditions, which is significant change. The succeeding phase represents the beginning of Middle Eocene transgression (major Kirthar transgression, Nagappa[2]), one of the most widespread of all Lower Tertiary transgressions. The *Corbula subexarata* zone and reptilian zone probably represent estuarine-marine conditions during their deposition. Later, the sea became deeper as is evident by the appearance of *Nummulites* and complete disappearance of the above fauna and flora.

Further, according to Nagappa,[2] the base of Middle Eocene is not clearly marked in Kutch, but the author has observed that in the section under study, the base of Middle Eocene is marked by Unfossiliferous zone, dicot leaf zone, *Corbula subexarata* zone and reptilian zone.

The mammalian and reptilian fossil remains have been traced up to Gothathad (23° 39′ : 68° 39′ 30″), about 14·5 km N 10° W of Harudi and Nareri (23° 40′ : 68° 25′ 30″) about 16 km N 3° W of Harudi.

The author is indebted to Prof. R. C. Misra (Head, Geology Department), for kind guidance. Thanks are due to Mr. Girjesh Chandra and Dr. Ashok Sahni for suggestions.

Geology Dept., K. K. TANDON.
Lucknow University,
Lucknow-7, India, *March* 23, 1971.

---

1. Tandon, K. K., *Acad. Thesis*, Lucknow Univ., 1966, p. 93.
2. Nagappa, Y., *Micropaleontology*, 1959, **5**, 192.

EFFECT OF REPUGNATORIAL GLAND SECRETION ON THE OXYGEN CONSUMPTION IN THE MILLIPEDE, *POLYDESMUS*

REPUGNATORIAL gland secretion in millipedes serves as chemical defence against predators. The chemical nature of this secretion in different millipedes varies widely. It has already been noted that *Polydesmus virginiensis*[1] secretes hydrocyanic acid while *Pseudopolydesmus serratus*[2] secretes hydrogen cyanide.

In the present study, two species of millipedes of the genus *Polydesmus* were used and it is interesting to note that the secretion given off by their repugnatorial glands is extremely poisonous. When a few millipedes are agitated in a 10 ml tightly closed bottle, the poisonous secretion produced by the repugnatorial glands kills all of them in 30-35 min. When a few species of insects were put in the same chamber with *P. gracilis*, the effect of the poison was found to be variable as shown in Table I. Similar response was also observed with the other *Polydesmus* sp. (unidentified).

TABLE I

Species of insects		Time taken to knock down (in secs.)	Recovery time (in secs.)
1. *Musca domestica*	..	25	Died
2. *Culex pipiens*	..	63	"
3. *Apis mellifera*	..	73	2400

Pressure-sensitive manometers as described by Teal,[3] but slightly modified, were used for the measurement of oxygen consumption at 30° C. Soon after poisoning, it was observed that the rates of oxygen consumption decreased by 30% and 44% of the normal rates in *Polydesmus gracilis* and *Polydesmus* sp. respectively as shown in Fig. 1. This response in these millipedes possibly explains that the repugnatorial gland secretion might be a respiratory poison (hydrogen cyanide) as in *Polydesmus virginiensis* and *Pseudopolydesmus serratus*. The chemical nature of the secretion is under investigation.

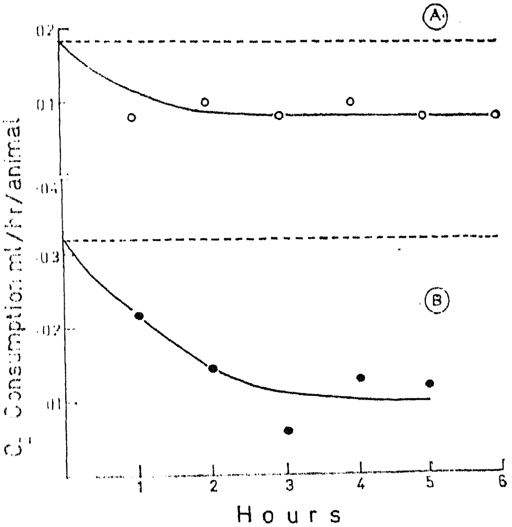


FIG. 1. The rate of oxygen consumption of (A) *Polydesmus* sp. and (B) *Polydesmus gracilis* (only males used) at 30° C. Dotted lines denote normal rate and unbroken line, the rate after poisoning.

We wish to thank Dr. M. A. Thangaraj, Principal, American College, Madurai, for his encouragement and financial assistance.

Dept. of Zoology, S. K. DWARAKANATH.
American College, O. G. W. BERLIN.
Madurai-2, Tamil Nadu, A. K. R. THILAGAR.
S. India, *April* 15, 1971.

---

1. Wheeler, W. M., *Psyche*, 1890, **5**, 422.
2. Eisner, T., *Ann. Rev. Entomol.*, 1962, **7**, 107.
3. Teal, J. M., *Physiol. Zool.*, 1959, **32**, 1.

A SPECIMEN OF *CALLICHROUS MACROPHTHALMUS* (BLYTH) WITH A FORKED RIGHT BARBEL.

TERATOLOGICAL variations of different types in fishes have been recorded by various workers (Hora, 1921; Kapoor and Sarkar, 1955; Sarkar and Kapoor, 1956; Sarkar and Kaushik, 1958; Tilak, 1961; Datta Gupta and Tilak, 1962; Tandon, 1964). But the presence of a forked barbel in nature is unknown in the literature.

The present specimen of *C. macrophthalmus* caught on November 10, 1969, from Patran (District Patiala, Punjab) is a spent recovering female, measuring 24·7 cm in total length and weighing 103·200 g (formalin preserved). The fork of the barbel starts 3·1 cm from its origin (Fig. 1). The abnormality appears to be the result of some accidental injury. Experimental regeneration of barbels in *Heteropneustes fossilis* has not produced any forking of the barbels in the laboratory.

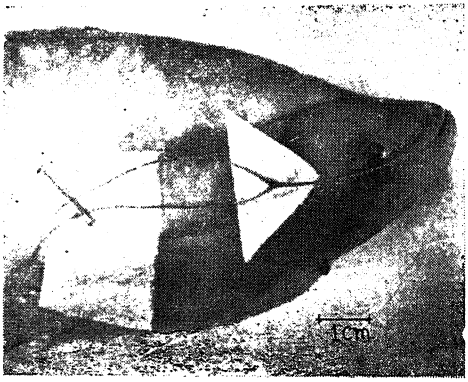


FIG. 1

This abnormal specimen has been deposited in the Museum of the Department of Zoology, P.U., Chandigarh.

Dept. of Zoology,
Panjab University,
Chandigarh, India,
May 4, 1971.

K. K. TANDON.
K. SHARMA.

---

1. Datta Gupta, A. K. and Tilak, R., *Zoologica Poloniae*, 1962, **12**, 305.
2. Hora, S. L., *Rec. Indian Mus.*, 1921, **22**, 27.
3. Kapoor, B. G. and Sarkar, H. L., *Proc. nat. Inst. Sci. India*, 1955, **21**, 129.
4. Sarkar, H. L. and Kapoor, G. B., *J. Zool. Soc. India*, 1956, **8**, 157.
5. — and Kaushik, K. N., *Proc. Zool. Soc. Calcutta*, 1958, **11**, 39.
6. Tandon, K. K., *Res. Bull. Panjab Univ.*, 1964, **15**, 351.
7. Tilak, R., *Sci. & Cult.*, 1961, **27**, 263.

STUDY ON THE RELATIONSHIP BETWEEN BRANCHING AND FLOWERING PATTERN IN CULTIVATED VARIETIES OF GROUNDNUT (*ARACHIS HYPOGAEA* LINN.)

IN order to study the general pattern of flowering in cultivated varieties of groundnut (*Arachis hypogaea* Linn.), a wide spectrum of germplasm, consisting of 225 lines—including both locals as well as exotics, were grown at the Regional Research Station of the Indian Agricultural Research Institute, Hyderabad, during the monsoon periods of 1968 and 1969. Of these, 45 were Valencia, 61 Spanish, 47 Virginia bunch, semi-bunch and semi-spreading and the remaining 72 spreading types.

The varieties were sown in single row plots of 10 meters length, replicated three times and randomised within. The crop was raised under rainfed conditions. A total of 20 kg of nitrogen (ammonium sulphate), 60 kg of P_2O_5 (superphosphate) and 30 kg of K_2O (muriate of potash) per hectare was applied as a basal dose at the time of sowing. Distance between rows and between plants and other cultural and agronomic practices were practically the same as locally recommended for a successful crop of groundnut. Daily records of flowers were made throughout the growing period from single plants selected at random in all the three replications and the average number of flowers produced per week per plant were calculated.

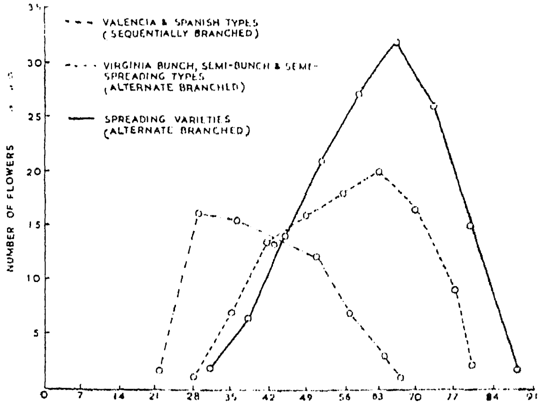


FIG. 1.

Flowering pattern was consistent between the two years among the varieties studied. Though individual variations were found between varieties, in general, it appeared from these data that the cultivated varieties of groundnut can be distinguished into two characteristic main groups, based on their flowering pattern and branching arrangement of the main shoot.

The sequentially branched types consisting of Valencia and Spanish groups practically showed no differences in their flowering, and they were, therefore, treated as a single group throughout this study. These flowered early in about 22 days from the date of sowing and exhibited a sudden increase in their flowering, producing the maximum number of flowers in the fifth week itself, subsequent to which there was a gradual reduction. The alternately branched types which include Virginia and spreading, flowered late in about 28-31 days and they showed a gradual increase in the number of flowers produced, with the maximum observed at about the ninth week from the date of sowing, after which there was a general reduction. Flowering in alternately-branched group extended over a longer period than in sequentially-branched varieties by about 15 days. In this respect, the number of flowers produced in spreading varieties is greater than in Virginia types. It was interesting to note that the sequentially-branched types produced considerably lesser flowers than the alternately-branched forms. None of the varieties studied were found to be intermediate in their flowering pattern between the two groups of alternately- and sequentially-branched types. This provides further support to the classification recommended by Sarma *et al.* that the cultivated varieties of groundnut should be mainly divided on the basis of their branching pattern, and not according to their growth habit, and that virginia-bunch, semi-bunch and semi-spreading types should be grouped together with the spreading varieties for breeding and other purposes of comparison.

Though flowering pattern in cultivated varieties of groundnut was extensively studied by Ali Mohammed *et al.*,[2] Shibuya,[3] Gregory,[4] Bouffil,[5] Smith,[6] Seshadri[7] and Varisai Mohamud,[8] in which different patterns of flowering were recognised, the present study suggests for the first time that the variations in flowering pattern are dependent on the branching arrangement of the stem in the cultivated groundnut.

The authors are thankful to Dr. M. S. Swaminathan, Director, Indian Agricultural Research Institute, New Delhi, for suggesting the problem on the classification of cultivated varieties of groundnut and keen interest throughout the course of the work.

Atomic Energy Lab., V. S. SARMA.
Genetics Division, R. VIZIAKUMAR.
Indian Agric. Res. Institute,
New Delhi-12, *April* 15, 1971.

---

1. Sarma, V. S., Viziakumar, R. and Kulkarni, L. G., *Curr. Sci.*, 1970, **39**, 259.
2. Ali Mohammed, Alam Zafar and Khanna, *Agri. and Livestock in India*, 1932, **3**, 91.
3. Shibuya, T., *Taihoku Imperial Univ. Fac. Sci. and Agri. Memories*, 1935, **17**, 120.
4. Gregory, W. C., *68th Ann. Rept. N. C. Agr. Expt.*, 1946, p. 33.
5. Bouffil, F., *Paris Bulletin Scientifique*, 1942, **1**, 12.
6. Smith, B. W., *Amer. J. Bot.*, 1950, **37**, 810.
7. Seshadri, C. R., *Groundnut*, Published by I.C.O.C., Hyderabad, 1962.
8. Varisai Muhammad, S. and Stephen Dorairajan, M., *Madras Agri. J.*, 1969, **56**, 239.

EFFECT OF SEED INOCULATION WITH *PSEUDOMONAS* SP. ON PHOSPHATE UPTAKE AND YIELD OF MAIZE

SEED inoculation with *Pseudomonas* sp. has been found to increase the yield of various crops.[1-3] Significant increases in phosphate uptake and crop yields due to inoculation with *Bacillus megaterium* var. *phosphaticum* have been reported.[4] The present note reports the effect of seed inoculation with *Pseudomonas* sp. on phosphate uptake and yield of maize.

A pot culture experiment was carried out with maize treated with hydroxy-apatite tagged with P^{32}, as an insoluble phosphate source at the rate of 80 kg P_2O_5/hectare. Alluvial sandy loam soil from Delhi of pH of 8·0 and 35 kg P_2O_5/hectare available phosphorus was used in this experiment. Tagged hydroxyapatete was prepared by adding radioactive phosphoric acid to 10% solution of dipotassium hydrogen phosphate following the procedure described by Sperber.[5] Basal dose of 100 kg N/hectare and 40 kg K_2O/hectare in the form of ammonium sulphate and muriate of potash was applied. Seeds were inoculated with *Pseudomonas* sp. (27 B), a good rock phosphate solubilizer,[6] and *Bacillus polymyxe* (H 5) and sown.

The crop was harvested after eight weeks. Phosphate content of the plants was estimated by vanadomolybdate method.[7] Radio Phosphorus in the digested plant material was determined as described by Mackenzie and Dean.[8] GM counter with binary scaler was used for recording the data. From the radioassay data the uptake of fertilizer and soil phosphorus was calculated.

The total dry yield, total phosphate uptake and uptake from added phosphate source and soil phosphorus are given in Table I.

TABLE I

Uptake of phosphorus from soil and added insoluble hydroxyapatite

(Average of three replications)

Treatments	Dry matter yield/pot (g)	Total phosphate uptake mg P/pot	Uptake of phosphorus Hydroxyapatite (mg)	Soil (mg)
Uninoculated ..	15·30	31·62	6·87	24·75
Pseudomonas sp. (27 B)	28·70	65·12	11·71	53·41
Bacillus polymyxa (H 5)	17·37	36·94	8·44	28·50
C.D. at 5% ..	5·95	20·46	N.S.	14·28

N.S.—Not significant.

Statistical analysis of the data revealed significant increase in dry matter yield and phosphate uptake by the plants due to seed inoculation with *Pseudomonas* sp. but not with *B. polymyxa*. Inoculation with *Pseudomonas* sp. resulted in significant increase in uptake of soil phosphorus but this was not so with *B. polymyxa*. However, the amounts of hydroxyapatite phosphorus solubilized by the cultures did not differ significantly from that of uninoculated control.

Our thanks are due to Dr. W. V. B. Sundara Rao, Dr. N. S. Subba Rao and Dr. B. Ramamoorthy for providing necessary facilities.

Division of Microbiol., S. K. KAVIMANDAN.
Indian Agric. Res. Inst., A. C. GAUR.
New Delhi-12,
April 17, 1971.

---

1. Smallii, V. T.. *Akad. Nauk. Ukrain SSR. Kieu.*, 1958, p. 153.
2. Myskow, W., *Acta Microbiol. Polon.*, 1961, **10**, 395. *Soils & Fertilizers*, 1962, **25**, 301.
3. Taha, Mahmoud, Halim, S. A. Z., El-Damaty, A. H. and Abd. Et-Hafez, *Plant & Soil*, 1969. **31**, 149.
4. Sundara Rao, W. V. B., "Bacterial Fertilizers," In *Hand Book of Manures & Fertilizers*, ICAR Publication, Ch. 9. 1965, p. 186.
5. Sperber, J. I., *Aust. J. Agri. Res.*, 1958, **9**, 782.
6. Bardiya, M. C., "Studies on Microbiological Solubilisation of rock phosphate," *Ph.D. Thesis*, I.A.R.I., New Delhi, 1970.
7. Koening, H. A. and Johnson, C. R., *Indust. Eng. Chem.* (Anal. Ed.), 1942, **14**, 155.
8. Mackenzie, A. J. and Dean, L. A., *Anal. Chem.*, 1948, **20**, 559.

COMPARATIVE STUDIES ON THE EFFECTS OF BOSEIMYCIN AND STREPTOMYCIN IN *BACILLUS SUBTILIS*

BOSEIMYCIN[1,2] is a basic water-soluble, broad spectrum antibiotic. Preliminary studies on the biochemical changes induced by boseimycin were carried out with a sensitive strain of *Bacillus subtilis*. A comparison of such changes with those of streptomycin is reported here.

Medium of the following composition was used in all experiments: glucose, 10 g; glutamic acid, 5 g; KH$_2$PO$_4$, 1·76 g; MgSO$_4$.7 H$_2$O, 0·02 g; KCl, 5 g; MnSO$_4$.4 H$_2$O, 0·01 g; FeSO$_4$.7 H$_2$O, 0·01 g; water, 1,000 ml. The pH of the medium was adjusted to 7·1. Metabolic studies were performed by comparing the rates of utilization of various substrates. 250 ml Erlenmeyer flasks containing 80 ml of the medium were inoculated with 0·5 ml freshly-grown (24 hr-old) *Bacillus subtilis* culture and incubated at 37° C under stationary condition. Antibiotic solutions were added at subminimal inhibitory concentrations at zero time. Cells were separated from the broth by centrifugation, then washed twice with distilled water and finally dried overnight at 60° C and the dry weight of the cells was determined. The culture filtrates were preserved below 4° C for analyses. Estimation of glucose was done according to the method of Folin and Wu,[3] lactic acid by the method of Barker and Summerson,[4] phosphate by that of Hertha and Ephriam,[5] and nitrogen by nesslerisation. Readings were taken in a Klett Summerson photoelectric colorimeter. Quantitative estimation of nitrogen and phosphorus were carried out on aliquots previously digested with sulphuric acid. The results of analyses are summarized in Tables I and II.

In the above growth medium, under stationary condition, it was observed that a maximum growth in control culture reached after 93 hours and subsequent loss of weight is accounted for lytic action of the cells, whereas in both boseimycin- and streptomycin-treated cultures growth continued even after 93 hours. The growth rate in the antibiotic-treated culture was low and this slower growth rate is comparable to the rate of utilization of different substrates in the medium. The medium maintained a steady lower pH value in the treated cultures all through the growth period. In control experiment, maximum lactic acid production reached during